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THE week of April 30 to May 5 marks the gathering in Washington of many leaders of the construction industry, intent on doing everything possible in behalf of further recovery for the construction and the capital goods industry.

¶ Activities scheduled for this notable week include meetings of the United States Chamber of Commerce, the Construction League of the United States, the Code Authority for the Construction Industry, and the Governing and Advisory Boards of the Associated General Contractors of America.

¶ These meetings will be attended by hundreds of contractors and other construction people from all parts of the United States. They will urge Congress and the President to continue the federal highway construction program, and to provide additional funds for further extension of the PWA program.

¶ Congressional action in this direction is an urgent necessity if recovery is to continue.

¶ Not all construction people can be in Washington during this week, but every one may play an effective part.

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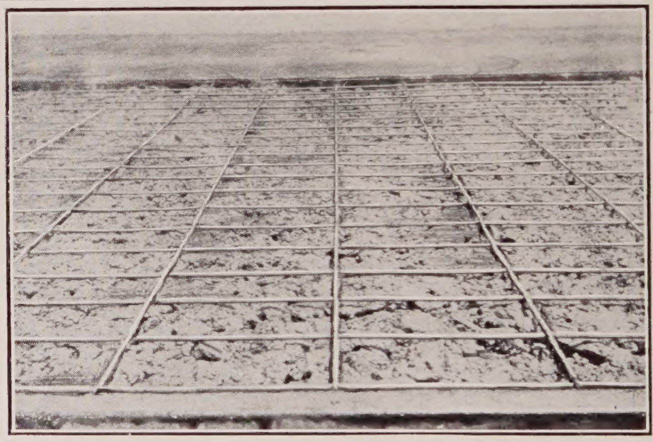

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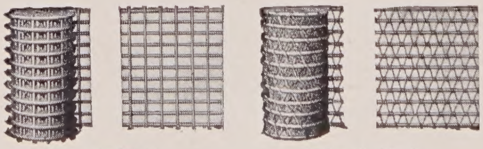

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Winter-Placed Concrete Paving Work Easily Protected

Methods and Results on Actual Projects—Protected Concrete Independent of Weather—Used High-Early-Strength Cement —Additional Cost Is Small

By D. S. MacBRIDE
Manager, Incor Division, International Cement Corporation, New York

In this discussion of the paper presented by H. F. Clemmer before the American Road Builders' Association, abstracted on pages 18 and 19 of the April issue of "Concrete," D. S. MacBride describes the actual procedure followed in placing concrete pavements in winter, and the manner in which the freshly-placed concrete was protected.

State highway departments should lose no time in starting plans for next winter's concrete paving program. The information contained in this discussion, and in the Clemmer abstract published last month, will be found of inestimable value in working out the details of such a program.—*Editor.*

In H. F. Clemmer's paper read before the A. R. B. A., and abstracted in the April issue of Concrete under the heading of "Highway Engineer Urges Year-Round Concrete Paving," he points out, by means of tests and field observations, the effect of low temperatures upon the early strength of concrete.

Good Reasons for Protecting Concrete

While it is true, as he indicates, that low atmospheric temperatures will reduce the temperature of unprotected concrete, such concrete need not necessarily be unprotected. In fact, there are good reasons why it should be insulated against heat losses, particularly at the early periods. Protection should begin as soon as the concrete is placed.

The chemical action responsible for the strength increase in cement requires moderate temperatures. This action is retarded by temperatures below 70 deg. F. and practically ceases below 40 deg. F. But this chemical action also generates heat. If concrete can be placed at a favorable temperature and the heat of hydration retained, hardening continues regardless of air temperatures.

The higher the initial temperature, the greater the volume of heat evolved, the more efficient the insulation against heat losses, the more rapid will be the strength gain and the sooner will the concrete become immune to freezing and be ready for service. Therefore, winter-placed concrete is heated, high-early-strength cements are used, and protection is provided against heat losses.

Job Experiences Prove Winter Paving Practical

This is all very academic. Yet its application has made possible road paving in severe winter weather and produced job data that at first glance seems to be in conflict with Mr. Clemmer's interesting studies. Yet there is no conflict because, due to the use of protective covering in the cases I will cite, concrete temperatures were to an extent independent of air temperatures. Because of this, strengths were obtained that greatly exceed the values reported by Mr. Clemmer at corresponding atmospheric temperatures.

A few examples will suffice to illustrate the point: A state highway project near Cincinnati, Ohio (FAP No. D539C) was built during the winter of 1932-33. Excavation, relocation of sub-structures and paving work went forward except in stormy weather. Sub-grade was prepared for a reasonable distance ahead and covered with straw. In the morning this straw was soaked with gasoline and burned, removing any light frost that may have formed in the sub-grade. Concrete was made with high-early-strength cement and heated aggregates, mixed and transported in the usual manner. The temperature of the concrete as laid on the sub-grade ranged from 60 deg. to 75 deg. F., and averaged 65 deg. To retain heat in the newly placed concrete a covering of burlap and straw was applied as soon as possible after finishing. It is interesting to note that concrete having a temperature of 60 deg. F. when placed in an atmospheric temperature of 35 deg., retained that placing temperature the next morning, even though the air temperature had dropped to 20 deg. or lower during the night. Tests made by the Ohio Highway Department upon 6 by 6-in. beams, and on cores cut from the pavement slab, gave the average results reported in the first table on the next page.

Six cores cut from this job and tested at the age of one year averaged 5,205 lb. per sq. in.

Age Days	Ultimate Strength in Lb. per Sq. In. Cores	Beams
1	1,716	235
2	2,858	384
3	3,760	534
7	4,630	750

During the past winter, paving projects were under way in several states. In each case high-early-strength cement was used; concrete was heated before placing and protected from heat radiation. Also in each instance low air temperatures were encountered, which were not wholly reflected in the temperature of the concrete or in the strength obtained. Opening strengths were obtained uniformly in from 48 to 72 hours, except during sub-zero weather.

Specific Job Results Cited

The more interesting of these projects and those which serve to bring out the points here discussed are the following:

1. Two sections of U. S. Route No. 1 through Philadelphia; the concrete, 1:1.8:3.75 mix, with 5 gallons of water, was placed during December and January. Specifications required that the concrete when placed have a temperature of 60 deg. F., which must not fall below 50 deg. before a modulus of rupture of 500 lb. per sq. in. was attained. Burlap and straw covering promptly applied conserved both the artificial heat and the heat of hydration, so that opening strengths were obtained within 48 hours despite an average air temperature of 45 deg. F.

2. Resurfacing of a concrete base from which a wood block top had been removed, on Ohio Street, Indianapolis, was accomplished with centrally-mixed concrete made to a strength specification. Delivered on the job at temperatures ranging from 58 to 80 deg. F., the average concrete temperature was 67 deg. While concrete lost some of this temperature before covering was applied, some temperature observations are of interest. On December 20 concrete temperatures, upon delivery, ranged from 72 to 80 deg. F., while the air temperature was 42 deg. By the time covering was applied, the temperature of the concrete had dropped to 54 deg. The day following, air temperature at 9:30 A. M. was 32 deg., and 39 deg. at 11:30 A. M., while the concrete placed 24 hours before was 42 deg. It is interesting to note that temperature observations made on 6 by 12-in. cylinders, stored on the job in groups and covered with a heavy layer of straw, were found to be consistently lower than that of the corresponding pavement. One instance, on December 18, the air temperature was 38 deg. F.; cylinders 40 deg.; the pavement 64 deg. Compression tests on pre-moulded cylinders averaged as follows: One day, 1,260 lb. per sq. in.; two days, 1,460 lb. per sq. in.; three days, 3,820 lb.; seven days, 4,880 lb. This pavement was opened to traffic three days after concrete was placed.

3. Another Indiana project, this one an NRA job, was built under state highway supervision on the Lafayette Pike at the Indianapolis city line. A 1:2:3 mix was used; concrete placed between December 3 and January 20. Specifications required a 550-lb. modulus of rupture before opening to traffic. Heated centrally-mixed concrete was placed at an average temperature of 75 deg. F. Before covering with wet burlap and straw, from 10 to 15 deg. of this had been lost. A typical series of temperature data are as follows:

Date	Air	Concrete When Placed	Concrete When Covered	—24 Hours—		—48 Hours—		72 Hrs. Mod. of Rupture
				Air	Under Cover	Air	Under Cover	
12-10-33	37	73	----	19	46	21	44	----
12-13-33	33	75	62	28	59	62	68	522
1-2-34	28	84	64	27	50	27	48	----
1-16-34	36	85	----	24	45	29	50	550
1-7-34	40	70	72 hours later, Air 27 deg., Concrete 47 deg.					

The practice of wetting down the straw covering so that a frozen sheet would be formed over the concrete was followed on the latter part of this job. The under side of the ice was uniformly wet, the top dry and hard. Indications were that higher concrete temperatures were observed under a straw covering, which had been frozen, than under dry straw. The data are too meager to allow a definite statement on this point. Opening strengths were attained consistently within three days.

4. By far the most spectacular demonstration of what high-early-strength cement, with full cold-water protection, can accomplish under winter conditions was provided by a state highway project just completed in Ohio. This project was built in Butler County, Ohio, on State Highway Route 180 and U. S. Route 127. The paving consists of 7,000 lin. ft. of 9-7-7-9 concrete slab 30 ft. and 41 ft. wide. The contract was awarded on November 22, 1933; operations got under way three days later. The first concrete was placed on December 5, the last on December 30. Freezing temperatures were encountered almost from the start, but concrete was placed continuously during the progress of the work, with the exception of one or two days when the subgrade was not ready.

The usual cold weather precautions were taken on this job. Finished grading operations were confined to within 500 ft. of the mixer, and the subgrade was protected from the weather with a covering of burlap and straw. Upon removing covering any frosted subgrade was thawed out with hot water and steam; similarly, forms were preheated preparatory to placing the concrete slab.

Aggregates were heated by steam pipes at a batching plant, and water in a boiler at the mixer. Concrete was placed on the grade at an average temperature of 70 deg. F. After finishing, the concrete was covered with wet burlap and straw to a depth of 10 in. This covering was maintained until the required beam strength (600 lb.) was obtained.

The 6 by 6 by 42-in. test beams were made from each day's concreting, cured and protected with the pavement. Three breaks were taken from each beam, with job apparatus. Cores were also made for test. Results of tests on 36 beams made to December 23 revealed that the required flexural strength of 600 lb. for opening the pavement to traffic was obtained in a number of instances in 48 hours, the average being 72 hours. Average core test results were as follows:

Age	Lb. per Sq. In.	No. of Tests
24 hours	1,886	4
48 hours	2,341	4
72 hours	3,332	5
7 days	4,382	6
14 days	5,537	5

A particularly interesting test series was made on the concrete placed on December 26. The first night the temperature dropped to 7 deg. below zero. The next morning surface readings taken under the covering indicated a concrete temperature of 44 deg. F. Air temperature at that time was 6 deg. above zero. On the third night the air temperature dropped to 5 deg. below zero. The following tests made on cores cut from the pavement of that day's run are significant—24 hours, 1,509 lb.; 48 hours, 2,612 lb.; 72 hours, 2,610 lb.

Should Regulate Concrete Temperatures Only

It should be noted in all instances cited that concrete temperatures were considerably higher than those observed for air. Since strengths are dependent upon concrete, not upon air temperatures, it seems that steps which are taken to prevent heat radiation are well worth while. I have felt for some time that winter specifications should regulate concrete temperatures only, and that air temperatures may be neglected, since the latter are of importance only as they affect the protection required and need not necessarily influence the final results.

Experience during the last two winters has convinced me that highway construction is capable of tremendous expansion. Instead of throwing thousands of men out of work as winter settles down, the road building industry can provide employment for a substantial percentage of the workers, who are depending upon it for a living. The added cost of winter concrete paving is much less than generally expected. Bidding data, plus field observations, indicates that an increment of 25 cents per square yard, in which is included the slightly higher price of high-early-strength cement, is ample to cover the cost of winter paving over summer construction. When this means of relieving unemployment is compared with the so-called dole, or with made-work projects, its points of superiority become apparent.

Cost of Light-Load Concrete Floors Reduced With Precast Joists

Bond Between Joists and Slab Produces Monolithic Reinforced Concrete Construction—Form Costs Very Low—Indianapolis Company Specializes in This Type

By M. STEELE CHURCHMAN
Engineer, Spickelmier Fuel and Supply Co., Indianapolis, Ind.

One of the most significant facts about floors of precast concrete joists and job-placed concrete slabs is that such construction is monolithic. The bond between the joists and the supported slab is as effective as if the joists were also job-placed.

Readers wishing further assurance on this point are referred to the conclusive tests reported by F. N. Menefee in an article on pages 5 and 6 of the March (1934) issue of "Concrete."—Editor.

EARLY in 1933 we directed our attention to reinforced concrete floors, having in mind a large market for floors in residences, apartments and other types of buildings which had relatively light live load requirements. We found that architects and contractors agreed that concrete floors had many advantages for buildings of this type.

A Wide Range of Advantages

Elimination of shrinkage, reduction of plaster cracking, protection from termites, insects, dry rot and vermin, control of fire and increased rigidity, were definite advantages mentioned. Other favorable points were seen in the prevention of the passage of dust through the floor, and the possibilities offered by beam-and-slab effects for ceilings which eliminated the necessity for and the cost of plastering. The trend for utilization of basement areas for "game" rooms was deemed an added advantage for a type of floor, the underside of which offered a light, attractive and clean-lined ceiling.

We were particularly anxious to obtain the viewpoint of architects on the question that concrete floors might tend to be cold and damp. It was encouraging to learn that architects dismissed this "bugaboo." Unanimously they stated that concrete floors were now used almost exclusively for large buildings requiring fireproof construction and for residences of the better grade. They said that practically every hotel and hospital today has reinforced concrete floors and that no complaints of this nature ever came up. It was their opinion that occupants of all homes, from the modest to the more expensive, were entitled to the benefits of concrete floors.

Low Cost and Light Construction

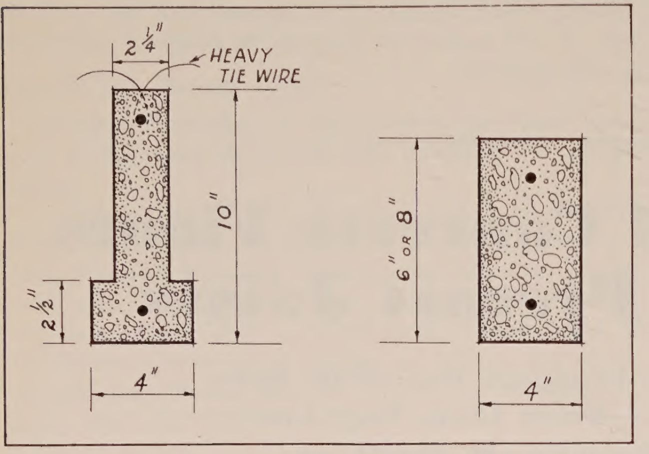
A logical question arose: Why are not more concrete floors used for small buildings? Architects and contractors gave two important reasons: First, some types of concrete floors suitable for large construction were too costly for small jobs. Second, these types of construction were not familiar to the craftsmen employed in building small structures. Our problem then was to recommend a type of construction that would retain the structural qualities of concrete floors and one that would be both low in cost and simple to build.

Two important factors influence the cost of concrete floors—dead weight and forms. Floors for carrying light loads do not require the same heavy construction as floors carrying heavy loads. The more common types of concrete floor construction do not permit freedom in design to accommodate light loads.

Why Precast Joists Are Economical

We decided that the use of a factory-made precast concrete joist would make flexibility possible. The use of such a unit would reduce the dead weight of the floor. At the same time we arrived at the answer to the problems of reducing form costs and providing simple construction.

Precast concrete joists serve as the supports for slab forms, eliminating expensive shoring, bracing and the forms for the joist sections. At least one-half of the cost of form labor is saved, besides a substantial saving in the cost of material. From the viewpoint of the builder, the precast concrete joist is handled like any other type of joist, so he works with a familiar type of construction.



Two types of precast reinforced concrete floor joists made by the Spickelmier company

The design of floors employing precast concrete joists is calculated on the principle of "T" beam construction in the same manner as any other type of concrete floor. Actual tests made by ourselves and others[1] conclusively show that for lightly loaded floors the job-placed concrete slab and the precast joist develop ample bond. Joists and slab are bonded together as a unit and may be designed as though they were placed at the same time. Most building codes require residence floors to be designed to carry a live load of 40 lb. per sq. ft.

Joists of Two Types

Two types of joists are manufactured. One is a plain rectangular joist utilizing pins which are slipped through holes cast into the joist at intervals. These pins support the formwork. The other type of joist is shaped like an inverted "T." The shelves of the "T" carry the formwork. In all cases we provide holes through the joist for B-X electric wiring conduit. These holes also serve for the attachment of metal lath or insulation for ceilings.

All joists are manufactured on order, to the required size and length. They are reinforced in accordance with standard design practice. Steel bars are placed in top and bottom of the joist, with the necessary shear reinforcement connections. Positive positioning of the reinforcing steel is secured. This point, easily accomplished in a factory, makes an especial appeal to architects.

Particular attention has been given to floor surfacing materials, although we have no floor materials for sale. Concrete floor finishes, particularly the attractive colored toppings which are now increasing in popularity, are the most economical. We make it a point to show the adaptability of concrete floors to take all standard coverings.

Special effort has been made to work out a practical detail for applying the regular hardwood flooring over concrete. The following method has proved successful. Creosoted wood screeds of 2-by-2 size are laid to level and fastened to the top of the joists by punched metal straps cast into the joists on 16-in. centers. Previous to fastening, spikes are driven into both sides of the screeds at close intervals, allowing spikes to project about 2 in. These projections serve as anchors after the concrete slab has been placed. Regardless of possible shrinking of the screed, the spike anchors hold the screeds rigidly. The wood floor is securely held and squeaks are eliminated.

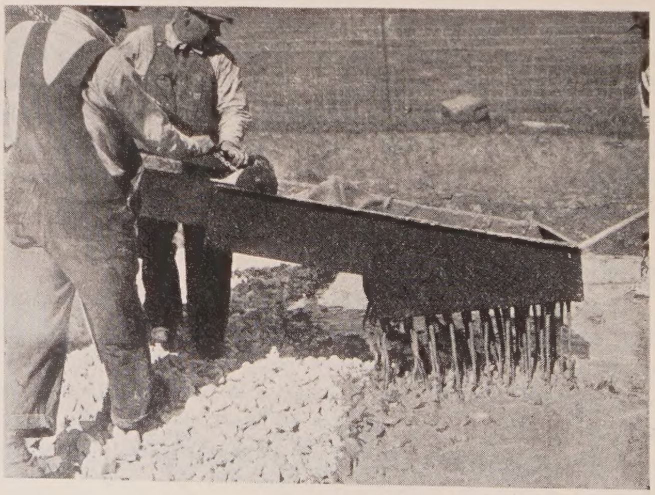
In presenting this simple, economical and practical type of reinforced concrete floor construction designed for lightly loaded structures, we feel that we have perfected a real service to the building industry. Better floors for better homes is a forward step.

Cement-Bound Macadam Grout Applied Vertically

Receiving Box with Holes in Bottom Found Most Practical Means of Distribution

EXPERIENCE has taught highway engineers the necessity of applying grout in cement-bound macadam construction in such a way that it hits the pavement surface in a vertical stream or streams. Standard specifications require the grout to be applied "in separated streams having a vertical drop of not more than 12 in."

The illustration shows a method that complies with the specifications. A wooden distributing box with a number of 1-in. holes drilled into the bottom is attached to the end of the discharge chute of the truck mixer. This box receives the grout from the chute, interrupting the flow and releasing the grout through the 1-in. holes in separated vertical streams, thus avoiding the dislodging of stones.



Box with 1-in. holes in bottom, attached to end of discharge chute of truck mixer, applies grout in separated vertical streams

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[1] See March (1934) issue of CONCRETE, pp. 5-6, for report of tests by F. N. Menefee.

Concrete Control Found Applicable to Small Construction Job

Ft. Wayne Uses Strength Specification for Concrete in Construction of Water Supply System — Economies Gained Exceed Cost of Control

By E. B. RAYBURN, JR.
Ready Mixed Concrete Corporation, Indianapolis, Indiana

DURING the past two years the city of Ft. Wayne, Indiana, has completed the construction of a modern water supply and purification system at an approximate cost of $2,000,000. Three separate contracts were let for construction: (1) The reservoir and settling basins of Three Rivers Filtration Plant, (2) the Three Rivers Filtration Plant, (3) the Anthony Boulevard Dam and pumping station. Each project required less than 10,000 cu. yd. of concrete.

Concrete Technologist Engaged

Unit No. 3 is located on the St. Joe River about 3½ miles north of the filtration plant. Raw water is pumped through a 42-in. line to the plant at an estimated rate of 36,000,000 gallons daily. Provision has been made for a small hydro-electric unit to supply emergency power for the pumps in case of a breakdown in the power system supplying the city. Construction on this unit was begun in the spring of 1933, and the pumps were put into operation during the latter part of December, 1933.

When work was commenced on unit No. 1 early in 1931 it was decided to engage a concrete engineer to design the concrete mixes and to supervise the production of concrete, his fee being paid by the contractor. This worked out to the satisfaction of the three parties concerned—the city, the engineers and the contractor—and it was decided to discard the arbitrary mix specifications in favor of a strength specification based on the water-cement ratio law. This specification was used on units No. 2 and No. 3, and to prevent uncertainty on the part of bidders, maximum cement contents were given for bid purposes, which were a close approximation to the final quantities.

Three Classes of Concrete

Some of the requirements for unit No. 3 are typical of the specifications for both jobs.

1. The contractor was to employ a competent concrete engineer, satisfactory to the engineers engaged by the city. It was his duty to design and control the concrete. Strengths should be determined at 28 days from 6 by 12-in. cylinders *cured on the job.*

2. Three classes of concrete were specified:

Class A. Minimum strength, 3,500 lb. per sq. in. at 28 days. For thin members subject to water pressure and/or exposure. Water-cement ratio not to exceed 6 gallons per sack (0.80).

Class B. Minimum strength, 3,000 lb. per sq. in. at 28 days. For thin structural members not subject to exposure or water pressure, and for heavy members subject to exposure. Water-cement ratio not to exceed 6¾ gallons per sack (0.90).

Class C. Minimum strength, 2,000 lb. per sq. in. at 28 days. For all gravity sections of dam. Water-cement ratio not to exceed 7½ gallons per sack (1.00).

Concrete Engineer in Complete Charge

The contractor placed the concrete engineer in complete control of concreting operations—design, production, mixing, placing, hauling, curing, etc.—as assistant superintendent. This was a departure from the usual procedure, in which the concrete engineer is considered merely a technician rather than a "boss." The scheme allowed greater flexibility in obtaining results both as to quality and economy.

Mixes were designed for the various classes and consistencies of concrete to be used on the job. An average grading of the aggregates was used in the design and a job curve was established with the cement ear-marked for the project, as required by the specifications.

When concreting began, the strength was controlled by maintaining a constant consistency and a grading of the aggregates within the limits of the design. From time to time during concreting operations, the water-cement ratio was checked. Since all materials were stock-piled there was only a small fluctuation in the moisture content of the aggregates. Curing was done by ordinary methods. From the results of the job cylinders the curing process was found to be quite adequate.

How Material Was Handled

Aggregates and cement were delivered to a siding about a mile from the job and hauled to the mixer in two 1-yd. batches, cement being dumped into a separate water-tight compartment. All batching was done by weight.

Sand and gravel were shipped in bottom-dump cars. Cars were dumped into pits underneath the track and handled by crane into the stock piles. Only one size of gravel, ¼ in. to 1½ in., was used, due to lack of space. While two sizes of gravel greatly lessen the danger of segregation, it was kept to a minimum in this instance by careful handling. The producer split the gravel into three sizes at the screening plant—¼ to ½ in., ½ to 1 in., and 1 to 1½ in.—and recombined them on the loading belt according to specifications. On delivery, the stock pile was built in nearly horizontal layers instead of the usual cone-shaped pile.

Cement was delivered in bulk and was handled by carts, as in an ordinary roadside set-up. On large runs of concreting four men were used—three men on carts and one man weighing cement, spotting trucks, etc. By placing the responsibility for the gang and for the weighing on one man, accuracy in this respect was assured.

Placing Concrete Under Vibration

Concrete for the dam and retaining walls was handled in two 1-yd. bottom-dump buckets. An industrial railway was used for transportation and a crane for placing. Concrete for the pump house and the bridge over the dam was handled by tower and buggied into place.

By using two high-frequency vibrators of the internal vibrating type it was possible to use much drier concrete than could be placed by ordinary methods. In the walls and piers a slump of from 4 to 5 in. was used, while in the dam it was possible and desirable to use a slump of 1 in. or less. This permitted a saving in two respects: (1) A reduction in cement quantities and pointing-up costs, (2) a saving in complicated form work by eliminating all forms from the downstream face of the dam where the slope was 45 deg. or less. For maximum efficiency two men were required on each vibrator, but this did not increase the number of men in the placing crew.

Test Methods and Results

In view of the requirement for job-cured cylinders, it was desired to obtain a curing condition for the specimens as nearly representative of the actual conditions in the structure as possible. To this end the specimens were placed in the wall or slab which they represented whenever practicable, and left until the day they were to be broken. During placing operations, cardboard molds, slightly larger than the 6 by 12-in. cylinder, were filled with sand and placed in the fresh concrete. The following day these molds were removed and the specimens inserted in the pocket formed. To prevent evaporation and loss of the heat generated by the hardening of the mass, the small space of about 1/8 in. left between the recess and the cylinder was caulked and sealed at the top. Cylinders removed at the age of 28 days were still moist.

Sampling and testing were done by the city chemist and his representative. Cylinders were broken at 7 and 28 days, and at earlier ages as a check on wrecking form work. As a check on the concrete control, cylinders were also made for moist curing at 70 deg., to be broken in the event a job cylinder failed to reach the minimum strength specified. In the few cases where this was necessary it was found to be the fault of the curing in each case. Since the curing conditions ranged from those of late spring to the chill of early fall, the uniformity of laboratory results could hardly be expected.

Results from the tests at 28 days are as follows:

	Number of Specimens	Design w/c	Specified Minimum, Lb. per Sq. In.	Average Strength, Lb. per Sq. In.	Average Variation, Per Cent
Class A	30	0.80	3,500	3,850	11.0
Class B	50	0.90	3,000	3,430	10.5
Class C	12	1.00	2,000	2,940	8.8

An examination of the job curve showed that the strengths from the Class C Concrete would far exceed the minimum required. The job results bear this out.

Control Methods Applicable to Small Jobs

Most large projects built in the last few years have required the services of a concrete engineer, but the general feeling has been that the small job—10,000 cu. yd. or less—did not warrant such refinement. This particular job required only 7,500 cu. yd., but the contractor was so well satisfied with the system that he plans to use it on future work. By furnishing the bidders with approximate quantities for bidding purposes, it was possible for the city to profit from the saving in cement while being assured of the quality of the concrete.

The use of vibrators is also becoming general on large jobs. On this small job they more than paid for themselves in many ways. The only objection to them was in the case of heavily reinforced walls over 8 ft. in depth. The weight and mass of the vibrators made them rather unwieldy and impaired their efficiency to some extent. For this type of placing a lighter and more flexible tool should be developed.

The use of job cylinders furnished accurate knowledge of the strengths actually obtained in the structure. They were also of value in allowing the early wrecking of form work. Job cylinders should be especially desirable for winter concreting, but more knowledge should be available concerning the relation between standard 6 by 12-in. cylinders and the smaller sizes which would necessarily have to be used in thin sections.

Acknowledgments

The project was built under the Board of Public Works, Ft. Wayne, Indiana. The engineers were Hoad, Decker, Shoecraft and Drury, with L. R. Matthews as resident engineer. Chas. R. Wermuth & Son was the contractor, and the writer had charge of the concrete, and was succeeded by G. Rozendale.

Building Inspection Officials Meet in Boston

Five-Day Sessions Crowded with Widely Diversified Program

A JOINT annual meeting of the Building Officials' Conference of America and the New England Building Officials' Conference was held in the Statler Hotel in Boston, Mass., from April 23 to 27, inclusive.

Papers of definite interest to the concrete construction industry included William F. Hurd's paper on the "Proposed Recommended Building Code for Cities and Towns of New England." Another was A. B. MacMillan's paper on "Index of Building Costs." Mr. MacMillan will be remembered by readers of CONCRETE as the author of a series of articles on concrete form work published in the issues of January, 1930, to January, 1931, inclusive.

"What Happens When Brick and Mortar Meet?" was the title of a paper by Walter C. Voss. The facts brought out by the author have similar application in the case of concrete building units.

Papers on Federal construction activities were presented by Robert D. Kohn, director of housing, Public Works Administration, Washington, D. C.; by Joseph H. Carney, Massachusetts administrator for the Federal Emergency Relief Administration; and by Charles R. Gow, Massachusetts state engineer for the Public Works Administration.

An interesting feature was the daily "question-box breakfast," where opportunity was afforded for discussions by small groups, and for submitting questions and problems.

In spite of an inexperienced crew, excessive rains, and a roller that was too heavy, Army crew builds excellent cement-bound macadam road at Fort Sheridan

Placing Cement-Bound Macadam with Inexperienced Crew

Construction Procedure Described by Officer in Charge of Work—Succeed Despite Handicaps

WHEN it was decided to build a cement-bound macadam road at Fort Sheridan, Illinois, late in 1933, it was necessary for the officers charged with this work to study the methods of construction. Since much of the available information was in the hands of the Portland Cement Association, which had just recently finished the construction of the Elmhurst, Illinois, experimental road, that organization was contacted. They made available all of their data, including specifications. All of our operations were based on their data and the results of the Elmhurst experiment.

A width of 27 ft. was selected, as this road was to be the main entrance to the Post. The road was divided into two strips by the use of a dummy longitudinal center joint. The thickness originally contemplated was to be 6 in. However, due to lack of experience in placing the aggregate, a much greater thickness was actually obtained. Wooden board joints at 100-ft. intervals were installed transversely across the pavement for expansion, the boards being left in place.

The coarse aggregate selected was a 1 to 2-in. crushed limestone. The sand, graded from 100 to 14, is known commercially as a plaster sand. We could have used a coarser sand (100-8) with the size of coarse aggregate which we had.

Placing Aggregate

After the forms had been constructed, the coarse aggregate was then placed on the subgrade with the intention of having its depth such that after compaction the final pavement would be of the desired thickness. This is not so difficult as it would appear, for during the Elmhurst road test various methods of compaction were used and definite compaction factors were determined. The percentage of compaction is based on the designed grouted depth. The compaction factor is then expressed as this percentage, plus one. The depth of the loose stone is computed by multiplying the compaction factor with the desired grouted depth and adding the estimated subgrade loss. The subgrade loss in virgin soil will vary from $\frac{1}{2}$ to 1 in. with a 6-ton roller for compaction. On an old traveled, well compacted earth road, the subgrade loss will be materially reduced. On an old stone base, there will be no subgrade loss.

Unfortunately, we attempted to level and spread the stone by eye. As a result, instead of placing the stone to a depth of $7\frac{1}{2}$ to 8 in., we had nearer 10 in. This caused our costs to increase beyond our calculated figures. I would strongly recommend, both from the standpoint of economy and from resultant smoothness of the finished surface, that the stone be placed with great care; and by all means do not trust the eye either for the depth or the surface smoothness. If spreader boxes are available, they should be used. The even spreading of the loose stone is the first requirement for a smooth-riding pavement.

Rolling the Stone

The only available roller was a $7\frac{1}{2}$-ton steam roller which actually had a weight of 8.6 tons when carrying coal and water. Proper construction requires the rolling of loose stone as soon as possible after it has been placed, because any rainfall before rolling will soften the subgrade and not only result in a large subgrade loss, but will also add to the difficulty of maintaining a smooth surface when rolling. Such was the case on our job at Fort Sheridan. We had heavy rains before the aggregate could be rolled. This, together with the excessive weight of the roller, would not allow us to key the stone properly nor maintain a true surface. It would have been possible to drain the subgrade if trenches and side ditches had been provided.

Grouting

Before actual grouting is undertaken, it is necessary to determine the fluidity characteristics of the grout mix to be used. Again referring to the Elmhurst road tests, it

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Condensed from paper read before the Twentieth Annual Road School, Purdue University, by Lieut. A. N. Stubblebine, F. A. (Q. M. C.), U. S. Army, Fort Sheridan, Illinois.

was found that 1 to 2-in. coarse aggregates required grouts having 20 to 22 seconds flow. On our job, the coarse aggregate was 1 to 2 in. in size and required a grout having this degree of fluidity. A flow curve for the particular sand and mix to be used was then made. Such a flow curve is essential. The amount of mixing water required to give a 20 to 22-second flow was obtained, and the degree of safety of the sand could be seen, at a glance.

The only mixer that could be rented was a 27-E caterpillar tread mixer of the boom and bucket type. It was necessary to devise some means of distributing the grout, for it was evident that it would be undesirable to deposit an entire batch at one time on the surface without retarding the velocity in some manner. It was decided to wire the gates of the bucket so that the maximum opening would not exceed ¾ in. A grout box constructed of wood of the same horizontal dimensions as the bucket was placed underneath the bucket and supported with four iron rods hung from the top of the bucket. This box was provided with 1-in. holes on 3-in. centers. This proved to be successful. The distribution of the grout could be controlled by running the bucket out to the end of the boom and returning the bucket to the mixer during discharge.

The grout was deposited continuously from side to side of the pavement and swept ahead with push brooms (we call them stable brooms in the army) to prevent formation of air and water pockets back of the grouting. Sufficient grout was left on the surface to leave a thin film over the coarse aggregate.

In order to check the thoroughness of the penetration, holes were dug through the coarse aggregate to the subgrade at some distance ahead of the grouting. These holes were observed as the grouting operations proceeded toward them. In all cases, unsegregated grout entered at the bottom of the test holes, when the grout on the surface was one foot or more away, which indicated satisfactory penetration. Should the grout have not entered at the bottom of the test hole when surface grout was within a foot of the hole, penetration would have been doubtful.

Final Rolling

During the first day's grouting operation there was no sunshine and the humidity of the air was high. Shortly after lunch a light rain began to fall. All of this, together with the excessive weight of the roller, worked against us in obtaining a final smooth finish. Usually the time between the grouting operations and final rolling will range from 30 minutes to about one hour. Final rolling should not be undertaken until there is a stiffening of the grout sufficient to support the roller without causing a quakiness of the mass. This is usually indicated by no further release of free water from the grout to the pavement surface.

Since our subgrade was in a very soft and wet condition due to these rains, it could not absorb any of this free water from the grout. Consequently, all of this water had to come to the surface, and evaporation was extremely slow due to high humidity and cloudy weather. Grout which was deposited at 11 o'clock in the morning was not ready for final rolling until 4 P. M. that day. Grouting operations were stopped shortly after 3 o'clock, but it was necessary to carry on the work late into the night before we could complete our rolling and finishing operations. During rolling operations, hand squeegees or light push brooms were used to distribute the grout evenly over the surface, and to remove excess grout.

Finishing

After rolling, the surface was gone over from two to three times with a longitudinal tamping template in order to remove any surface irregularities caused by the rolling operation. This was immediately followed by floating the entire surface with a long-handled wooden float. The surface was then smoothed by dragging a strip of wetted burlap over it longitudinally. The final surface finish was obtained by brooming.

During our second day's grouting, which was also the last, we decided to accelerate the hardening of the grout by an admixture of about 2 lb. of calcium chloride per sack of cement. This was added in solution as a part of the mixing water to the last 50 ft. of grout poured. We finished grouting at about 5 o'clock. We should have added this admixture sooner, as the last 50 ft. set up faster than the section preceding it. By the time we reached it with the roller the surface had become so hard that little could be done with it, and, to add to the difficulty, finishing operations had to be continued after dark. The resulting finish was not as satisfactory as we desired. Under similar circumstances I would use calcium chloride throughout the full day's operation.

Conclusion

To sum up, we learned a great deal about practical construction work on this type of road. Bear in mind that we had an inexperienced crew, short duration of work (2 days of grouting), and adverse weather conditions and a roller too heavy for this kind of work. In spite of these handicaps, we did obtain a substantially good pavement as far as quality and serviceability are concerned, but the surface finish on some sections left much to be desired. On any future work of this type we could eliminate the mistakes we made and produce a pavement with a satisfactory surface finish with much less effort than we put into the work here described.

Important Promotions at University of Illinois

PROFESSOR Melvin L. Enger, a member of the University of Illinois faculty since 1907 and head of its department of Theoretical and Applied Mechanics since 1926, was named dean of the College of Engineering and Director of the Engineering Experiment Station of the University, by the Board of Trustees in session at Urbana on April 11. Arthur Cutts Willard, who was recently elected President of the University, has been serving as Acting Dean of the College of Engineering this year.

To fill the vacancy caused by the election to deanship of Enger, Prof. Fred B. Seely, a member of the faculty since 1909, was named Theoretical and Applied Mechanics Department head. Another vacancy, caused when president-elect Willard was promoted to the engineering deanship, was also filled by the Board when it named Prof. O. A. Leutwiler to head the Department of Mechanical Engineering. Willard was for years head of that division. Leutwiler has been a member of the engineering faculty since 1903 and has been professor of mechanical engineering since 1921.

◆ EDITORIAL ◆

Subsistence Homestead Star Is Rising

ONE governmental activity that is making notable progress, though but little publicity has been given out on it, is the move toward the development of subsistence homesteads.

An article in this issue discloses that some four thousand homes are involved in projects thus far approved for allotments out of the $25,000,000 fund made available by the government.

The cost figures and the terms of payment announced are almost unbelievable when compared with the dizzy transactions of the decade following the World War. It may well come to pass that homes of the subsistence homestead type will prove the most potent single influence in the revival of construction activity.

One of the most encouraging features about the subsistence homestead movement is that, once the government has shown the way, private enterprise will be free to step in.

Private enterprise, as a matter of fact, is free to develop such projects now. What the government is really doing is to supply facts which private corporations may utilize, so that a reasonable profit may be assured.

The question is, will private enterprise give the home buyer a square deal or will it again exploit him?

A Wrong Conception of Duty

ANOTHER painful illustration of the manner in which a public official often seeks to impose his personal opinions, preferences or prejudices in opposition to nationally accepted construction standards and practices developed recently in Joplin, Mo.

The city had obtained an allotment from the PWA for an extension to the sewer system. City officials wished to use concrete sewer pipe, not only because of previous satisfactory experience with them, but because of the desire to use a product that was manufactured locally.

Colonel Hugh Miller, state head of the Public Works Administration, however, demanded that if concrete pipe were used it would be necessary to coat the interior surface with a bituminous material.

Apparently Colonel Miller gave no consideration to the fact that the American Society for Testing Materials' long-established "Standard Specification for Cement-Concrete Sewer Pipe," adopted in 1924, contains no such provision. Possibly he regards his own opinion as having greater weight than the combined opinions of the men who are responsible for the A. S. T. M. specification—a specification that was founded on past experience and performance even at the time of its adoption.

To require concrete pipe to be coated with a bituminous material will, of course, increase its cost. In consequence, it will be placed at a disadvantage in the competition with other materials. Competing interests, quite naturally, often attempt to impose this additional cost on concrete pipe.

As the result of Colonel Miller's arbitrary attitude, the city was compelled to incur the additional expense of sending several city officials to a public hearing in St. Louis, and to pay the cost of collecting and preparing data and exhibits to present before the hearing. Worst of all, there was a distressing delay in getting started on the work, at a time when work was sorely needed by the unemployed.

The construction industry will be relieved of much unnecessary cost and many needless delays when public officials have learned to suppress their own personal opinions and to accept the standards adopted by national technical societies.

Superior Reinforcing Steel

A SUPERIOR type of reinforcing bar, used in Germany for the past five years and now being tested in England, may necessitate a revision of construction specifications and regulations in this country, so far as they affect steel reinforcement.

The "Isteg" bar, the name by which it is known in Europe, is nothing more than a strand of two mild steel bars, twisted together with a pitch of 10 to 15 times the diameter of the individual bars. The stretching increases the yield point, and the twisted bar has greater bond strength than the individual untwisted bars.

Tests now being conducted by the Building Research Committee in London indicate a yield point ranging from 89 to 96 per cent of the ultimate strength, while untwisted bars of the same stock have a yield point ranging from 60 to 75 per cent of the ultimate tensile strength.

Construction regulations in force in Prussia for several years permit a unit working stress of 25,500 lb. per sq. in., compared with 17,000 lb. for untwisted bars of the same grade of steel.

American and Canadian designers of reinforced concrete structures will demand more information about this type of bar, for they can not afford to lag far behind Europe in a matter of this kind.

Our producers of steel reinforcing bars should lose no time in starting an investigation of the merits of this method of treatment when applied to bars of mild steel available on this side of the Atlantic.

PROGRESS—In a Page

Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.

Distribution Modulus as New Basis for Design of Concrete Mix

BULLETIN No. 14, comprising the "Report on Tests Made by the Austrian Committee on Reinforced Concrete," explains in detail the progress made toward simplifying the rational design of concrete mixtures. The tests were conducted under the direction of Dr. Ing. R. Tillmann. The committee believes that a simple and natural method has been found to replace the hitherto existing descriptive and comparative design methods by generally valid mathematical determinations.

Dr. Tillmann's sub-committee has rendered an excellent service by including purely mechanical and nomographic expedients which make any calculating in the laboratory or on the job superfluous. This arrangement indicates a clear understanding for the requirement of practice, since experience teaches that the best theory gains practical use only when it is aided by facilities, simple and easy to handle.

In order to characterize briefly the nature of the test results it may be said that the work and ideas of Abrams and Bolomey have been continued. Abrams' fineness modulus has been developed into the kornpotenz (particle power), being used by Testing Engineer Zeissl to establish the *distribution modulus* which characterizes unequivocally a definite grading of particles. He derived at the same time (like Bolomey) the water requirement of the aggregate from the sum of the influences of the individual sizes. Zeissl differs from Bolomey in the basic function of the influence factor, since the kornpotenz had not yet been available to Bolomey, who had to make corrections with the help of empirical coefficients.

Copies of Bulletin No. 14, priced at $3.00, may be obtained from the Osterreichischer Ingenieur- und Architekten-Verein (Society of Austrian Engineers and Architects), whose headquarters are at Eschenbachgasse 9, Vienna, Austria.

Influence of Temperature on Strength Development of Concrete

A REPORT by N. Davey, in Technical Paper Number 14, Department of Scientific and Industrial Research (London), 1933, tells of several years investigations of the effects of external and internal temperatures upon the strength development of concrete with modern types of cement. Laboratory tests were made on adiabatic curing of small specimens and corroborative evidence was obtained from large specimens. The conclusions are as follows:

1. Effects of hot cement under conditions likely to be found on a job are unimportant.

2. With portland cement, pre-heating of aggregates results in a marked acceleration in the development of strength in the first few hours after placing. Such preheating is inadvisable if used with high-alumina cements.

3. The strength of concrete is not likely to be impaired by any effect due to the temperature at which the cement was stored, either portland or high alumina.

4. Low temperatures delay the hardening of normal or rapid-hardening portland cement concrete. High-alumina cement concrete shows considerably less strength when cured at temperatures above 20 deg. C. Strength is not impaired if the concrete is kept cool through its early age.

5. In small concrete members, it is desirable to conserve the heat of hydration to accelerate strength development. In mass concrete, it is desirable to use cements which show slow evolution of heat. With high-alumina cement, every effort must be made to dissipate the heat of hydration as quickly as possible.

A method of estimating the amount of heat likely to be evolved by a concrete mix in a large mass, and the probable strength, has been developed and is described.

Isteg Bars Have High Yield Point

THE January issue of *Highway Research Abstracts* (Washington) contains a description of results obtained from the use of "Isteg" bars in Europe for the past five years.

These bars are made by twisting together two mild steel bars to form a rope of two strands. The stretching increases the yield point and the twisted bar has increased bond strength. Comparative tests show pronounced superiority for the twisted bars. Prussian regulations now allow working stress for the twisted bars of 25,500 p.s.i. while the plain bars of the same material are limited to 17,000 p.s.i.

The bars are twisted with a pitch of 10 to 15 times the diameter, these having given the best results. Too short a pitch overstrains the metal and too long a pitch does not stretch it sufficiently. During the twisting operation, the scale shells off. Tests of the bars are now under way by the Building Research Committee in London. So far, the tests have shown the yield point to be from 89 to 96½ per cent of the ultimate strength while for the untwisted bars the percentage is 60 to 75.

Effects of Volume Change in Masonry Cements

INVESTIGATION of the effects of volume change in masonry cements conducted by the U. S. Bureau of Standards, Washington, D. C., has disclosed that length change in alternate wetted (70 deg. F.) and dried (150 deg. F.) mortar specimens of masonry cements so weakens the specimens having the highest volume change that they break of their own weight. A duplicate set of specimens has been made and is undergoing 1 year's damp-closet storage at 70 deg. F. In this set, specimens that showed large length change in the alternate wet and dry storage are exhibiting a rapid increase in length. A study of the causes of staining of limestone by masonry cements has been started.

Two of concrete masonry homes in Dayton's subsistence homestead project

Subsistence Homesteads Show Way to Low-Cost Housing

Success Assured from Experience at Dayton Project—Concrete Masonry Most Economical Material—Modern Standards of Living Comfort and Sanitation

A FEDERALLY sponsored and financed housing program which has already given approval for the construction of some 4,000 low-cost houses has started under way in the past few months with but little public attention. Important in its own right from a construction standpoint, this movement may also point a new way toward solving unemployment and adequate housing problems in the low-income groups.

The foregoing has reference to the Subsistence Homesteads movement, operating as a division of the U. S. Department of the Interior, with a $25,000,000 allotment from the PWA.

Concrete Masonry Most Economical

At Dayton, Ohio, two subsistence homestead homes, built of concrete masonry, have been completed; several more are under construction. The Dayton project, originally privately sponsored, last fall obtained a $50,000 loan for 35 homesteads from the Subsistence Homesteads Division. In March of this year, additional allotments were made for three more units, bringing the total houses to 200.

In a search for low-cost materials, a government representative last fall spent two weeks at Dayton experimenting with rammed earth for walls. Experiments showed that because of labor involved in earth construction, concrete masonry was a lower cost material.

Easy Conditions of Payment

Each homestead consists of a house, 2 to 5 acres of land, and a small shed for chickens and supplies. Loans, at the Dayton project, are limited to land and materials. Homesteaders are expected to provide the labor for building their homes—either doing it themselves or exchanging labor with those who do the actual construction. Maximum loans range from $933.60 for a family of two or three persons to $1,179 for a family of 7 or 8. The labor expended will give the homesteader an initial equity of about $1,000. The balance is to be paid off in a maximum of 15 years, at approximately $5.00 per month for the first two years (during which equipment and livestock loans are paid). Payments will be $3.00 per month thereafter.

Need Permanent Types of Construction

The period of the loan necessitates a type of construction which will not require excessive upkeep and which will be in good condition at the expiration of the loan. Dr. Elizabeth Nutting, sponsor of the Dayton project, says: "The loan for building materials is based upon an estimate of a house of stone or concrete." These materials are not mandatory, but their value as low-cost permanent materials is recognized by inclusion in cost estimates.

Present plans call for a dozen or more homes with walls of Flagg type stone and concrete construction. All houses, no matter what materials are used, will have concrete foundations and floors.

Water Supply; Plumbing; Home Industry Equipment

Material estimates include money for septic tanks, a well for every four families, and piping of water into the homes.

Homesteaders will be expected to raise a large portion of their food. Canning equipment for providing a winter food supply will be installed. Many will have part or full time employment in nearby industrial plants. Sewing machines, looms, and other equipment for home industry are recommended.

The type of housing planned, while low in cost, will demand modern standards of living comfort and sanitation. Many of the families who will live in these homestead units are now living in miserably poor housing in congested city areas. The subsistence homestead unit idea aims to provide not only modern housing for low-income groups, but to improve the social condition of the workers.

Working Toward Ideal Home

Many of the homes will be improved and added to as their owners are able to make additional investments. Dr. Nutting explains the ideals of the Dayton project sponsors and members in these words:

"We are hoping that every member of a homestead carries within him a dream of the perfect house, and that he will build his first section with that clearly before him. But we are also hoping that we shall be the kind of dreamers who can work toward a dream instead of foolishly enslaving our futures by borrowing to realize it immediately."

Those in the concrete industry have reason to feel pleased with the selection of their material for the first houses built in this, one of the first subsistence homestead projects. Other projects in some 30 other locations in all parts of the United States have been approved, offering further opportunities to the industry.

Protect Eyes of Industrial Workers

RAMIFICATIONS of the steadily growing movement to eliminate the principal causes of blindness and reduce eye accidents to a minimum extend to industry and organized labor, is indicated in the annual report of the National Society for the Prevention of Blindness, made public recently. William Fellowes Morgan is president and Elihu Root is honorary president of the society.

The report points out that five states—New York, Pennsylvania, Michigan, Nebraska and Massachusetts—now require the use of non-shatterable glass in all automobiles. The Society's aid toward advancing this legislation was prompted by the serious eye hazard involved in automobile accidents. Non-shatterable glass has also been perfected for use in spectacles.

In the efforts to bring about more thoroughgoing protection of the eyes of industrial workers, the society has cooperated with such organizations as the National Safety Council, the American Federation of Labor, the United States Bureau of Standards, the Greater New York Safety Conference, and various State Departments of Labor and Industry.

Getting Durable Color Into Concrete

Mineral Colors Must Be Thoroughly Incorporated with Cement—Use of Ball Mills Recommended—Variety of Colored Cements Also Available

THERE are but few who can recall the "Dark Ages" of concrete, when a concrete unit was a source of grief to the trained eye and cultured mind of the architect. Those who do remember look back over the field of progress with considerable satisfaction at the advance made in this particular direction.

Much credit is due the manufacturers of mineral colors and of cast stone and portland cement stucco, who, after many years of experimental work, succeeded in putting permanent color into concrete.

Only twenty years ago it was difficult to find any color that would withstand the alkaline and lime action of portland cement. Greens were hard to obtain. Until very recently it was not easy to find a good black. Today there still remains a question in some minds in regard to a permanent blue; but this last obstacle, too, has been overcome.

Mixing Coloring Material with Cement

H. L. Childe, in his book on *Manufacture and Uses of Concrete Products and Cast Stone,* points out the importance of obtaining a thoroughly intimate mixture between the coloring material and the cement. "If color mixing is carried on to any considerable extent," he says, "it will probably pay to install a ball mill, which grinds the cement and color together and ensures thorough distribution of colors throughout the cement."

Colored Cements Available

The necessity of installing a ball mill in the individual concrete products or cast stone plant is now, however, a matter of choice with the plant management. For instance, on the Pacific Coast of this country, colored cements are being produced in which the color is introduced in the actual process of burning the cement clinker. Similarly, the Atlantic seaboard sections may obtain colored cements from abroad, especially from England—in which the coloring material has been ground in with the cement at the cement manufacturing plant.

Do Own Mixing with Ball Mill

Wherever, for reasons of economy or other reasons of their own, managers of concrete products and cast stone plants prefer to do their own mixing of colors and cements, it is urgently recommended that they follow Mr. Childe's suggestion by installing a ball mill of sufficient capacity to meet their requirements. Only in that way can they be sure of getting a thoroughly intimate mixture.

We are fast advancing out of the "Dark Ages" of concrete into that of color, effectiveness and beauty. There are splendid illustrations of such work in this country and abroad. Art and color in concrete need no longer be a question of doubt or durability.

Chemical and Physical Properties of Boulder Dam Cement

Limitations on Principal Compounds and on Heat of Hydration—Measure of Fineness Based on Surface Area of Particles in One Gram

ELWOOD MEAD, Commissioner, U. S. Bureau of Reclamation, Washington, D. C., recently issued a purchase specification known as Specifications No. 566, to control the purchase of 1,500,000 barrels of cement for Boulder Dam.

Bids for supplying this cement were received by the Bureau up to and including March 26. The points of interest to readers of CONCRETE, however, are the physical and chemical properties specified, inasmuch as these requirements disclose the essential differences between so-called normal portland cement and the special portland cement developed for Boulder Dam.

Reducing the Heat of Hydration

Readers are familiar with the purpose of employing a special cement in this massive structure—the purpose being mainly that of holding down the rate of heat generation during the hardening of the concrete. With this in view, the cement specified for the dam contains a higher percentage of dicalcium silicate and a lower percentage of tricalcium silicate than the percentages of these compounds usually found in so-called normal portland cements. How this chemical composition of the cement affects the rate of heat generation, as well as the total heat generated in the hardening process, has been fully explained in technical papers[1] written by the men who developed the cement specifications for Boulder Dam.

In the portions of Specifications No. 566, here reprinted, readers will find several features that are new to the average cement specification. For instance, limits are placed on the cumulative heat of hydration as determined by the heat of solution method.[2] Observe also the limits placed on the four principal compounds of cement, and the method for calculating the percentages of those compounds. Fineness requirements are specified on a new basis. The paragraphs that follow set forth these and other limits placed on cement for Boulder Dam:

References. Those parts of standard specifications of the American Society for Testing Materials, referred to herein shall form a part of these specifications.

Definition and type. Portland cement purchased under these specifications shall be the product obtained by finely pulverizing clinker produced from an intimate and properly proportioned mixture of materials selected to give the properties hereinafter specified, with no additions subsequent to calcination excepting water and/or uncalcined gypsum.

Chemical composition. The following limits shall not be exceeded:

	Per Cent
Loss on ignition	3.00
Insoluble residue	0.85
Sulphuric anhydride (SO_3)	2.00
Magnesia (MgO)	5.00

The ratio of the percentage of iron oxide to the percentage of aluminum oxide shall not exceed 1.5.

Compound composition. The theoretical compound composition when computed according to the method described below shall be within the following limits:

	Not more than
Tricalcium silicate ($3CaO.SiO_2$)	40 per cent
Dicalcium silicate ($2CaO.SiO_2$)	65 per cent
Tricalcium aluminate ($3CaO.Al_2O_3$)	7 per cent
Tetracalcium aluminoferrite ($4CaO.Al_2O_3.Fe_2O_3$)	20 per cent

Fineness. The specific surface of the cement shall be not less than 1,700 nor more than 2,300 square centimeters per gram as measured by the turbidmeter described in paragraph 31 of Specifications No. 566, but not repeated here.

Soundness. A pat of neat cement shall remain firm and hard and show no signs of distortion, cracking, checking or disintegration in the steam test for soundness.

Time of setting. The cement shall not develop initial set in less than 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours.

Compressive strength. The average compressive strength in pounds per square inch of not less than 3 cylindrical test specimens, 2 in. in diameter and 4 in. in length for each age of test, composed of mortar containing 1 part cement and 3 parts standard Ottawa sand by weight, as hereinafter specified, shall be equal to or higher than the following:

Age at Test (Days)	Storage of Specimens	Compressive Strength (Lbs./in.[2])
7	1 day in moist air, 6 days in water	1,000
28	1 day in moist air, 27 days in water	2,000

The average compressive strength at 28 days shall be at least 35 per cent higher than the strength at 7 days.

Heat of hydration. The cumulative heat of hydration as determined by the heat of solution method[2] shall not exceed the following:

Age (Days)	Heat of Hydration
7	65 calories per gram
28	75 calories per gram

In cases where an engineer wishes to calculate the percentage of tricalcium silicate and the other principal compounds of the cement he is specifying, he should obtain from the manufacturer a statement of the average chemical analysis as well as the average compound composition of his product. The engineer may then, following the method given in paragraph 30 of Specifications No. 566, and repeated below, check the cement manufacturer's figures by calculating the theoretical compound composition with the chemical analysis as a starting point. The method of calculation follows:

Compound computation. The compound composition shall be calculated from the chemical analysis by the method outlined below. This method is as given by Bogue in Paper No. 21, Portland Cement Association Fellowship on, "Calculation of the Compounds in Portland Cement," except that no account is taken of uncombined lime. Compound percentages shall be computed to tenths and reported to the nearest whole per cent.

(A) Method of calculation—Each per cent of SO_3 enters into combination with 0.70 per cent CaO to form 1.70 per cent $CaSO_4$:

$$\frac{CaO}{SO_3} = \frac{56.07}{80.065} = 0.70 \text{ per cent } CaO \quad . \quad . \quad . \qquad (c_1)$$

Each per cent of Fe_2O_3 enters into combination with 0.64 per cent Al_2O_3:

$$\frac{Al_2O_3}{Fe_2O_3} = \frac{101.92}{159.68} = 0.64 \text{ per cent } Al_2O_3 \quad . \quad . \qquad (a_1)$$

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[1] See condensed articles in CONCRETE, August, 1933, page 14, and October, 1933, pages 5 and 6.

[2] This method is given in detail in another part of Specifications No. 566.

and with 1.40 per cent CaO:

$$\frac{4CaO}{Fe_2O_3} = \frac{224.28}{159.68} = 1.40 \text{ per cent CaO} \quad . \quad . \quad (c_2)$$

to form 3.04 per cent $4CaO.Al_2O_3.Fe_2O_3$.

The total MgO is recorded as uncombined MgO.

The total Al_2O_3 minus (a_1) gives the Al_2O_3 (a_2) available for combination as $3CaO.Al_2O_3$. Each per cent of (a_2) will enter into combination with 1.65 per cent CaO to form 2.65 per cent $3CaO.Al_2O_3$:

$$\frac{3CaO}{Al_2O_3} = \frac{168.21}{101.92} = 1.65 \text{ per cent CaO} \quad . \quad . \quad . \quad (c_3)$$

The amount of CaO available for combination with SiO_2 is obtained by subtracting from the total CaO the sum of the CaO (c_1) combined as $CaSO_4$, the CaO (c_2) combined as $4CaO.Al_2O_3.Fe_2O_3$, and the CaO (c_3) combined as $3CaO.Al_2O_3$:

Total CaO — ($c_1 + c_2 + c_3$) = CaO available to combine with SiO_2 . . . . (c)

The total SiO_2 (s) is calculated first to combine with CaO to form $2CaO.SiO_2$. Each per cent of SiO_2 (s) will combine with CaO to form 2.87 per cent $2CaO.SiO_2$:

$$\frac{2CaO.SiO_2}{SiO_2} = \frac{172.20}{60.60} = 2.87 \text{ per cent } 2CaO.SiO_2$$

This first approximation to the value of $2CaO.SiO_2$ is subtracted from the SiO_2 (s) + CaO (c), which gives the CaO (c_4) available to combine with $2CaO.SiO_2$ to form $3CaO.SiO_2$.

Each per cent of CaO (c_4) combines with $2CaO.SiO_2$ to form 4.07 per cent $3CaO.SiO_2$:

$$\frac{3CaO.SiO_2}{CaO} = \frac{228.27}{56.07} = 4.07 \text{ per cent } 3CaO.SiO_2$$

The $3CaO.SiO_2$ subtracted from the total SiO_2 (s) + CaO (c) gives the true amount of $2CaO.SiO_2$ present.

While the supply lasts, copies of Specifications No. 566 (for portland cement for Boulder Dam) may be obtained from the United States Bureau of Reclamation, Washington, D. C.

How Fort Wayne Contractors Expose Chiselers

Permanent Exhibit Shows Public the Difference Between Honest and Dishonest Construction

CONCRETE contractors in Fort Wayne, Ind., who maintain a feeling of responsibility toward their customers and a pride in the quality of their workmanship need no longer compete against chiselers, so far as sidewalk and driveway construction and similar public works are concerned.

Through the co-operation of these contractors the Board of Public Works has resorted to penalty specifications and core tests to insure honesty in the construction of concrete sidewalks and driveways.

Because of the core tests, irresponsible contractors can no longer get away with 3 in. of lean concrete and 2 in. of cinders for what is supposed to be a 5-in. sidewalk of high quality. Subject to certain reasonable tolerances, contractors are penalized for sub-standard thicknesses or inadequate compressive strength of cores.

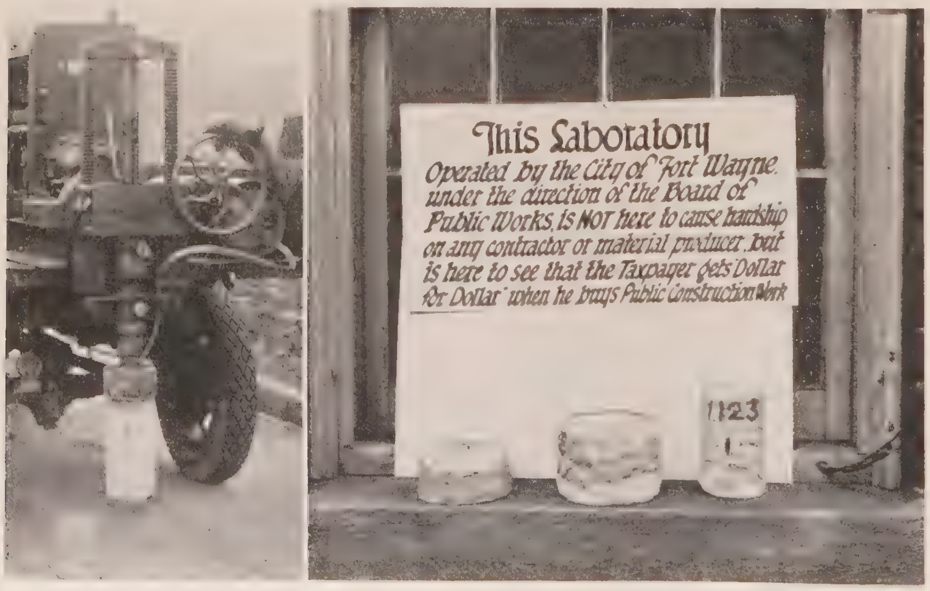
To aid the public in understanding the difference between honest and dishonest construction, the city laboratory, where the tests are made, maintains in its office the permanent exhibit shown in the illustration. The obvious purpose of this exhibit is explained in the poster.

Federal Government Stops Bid Peddling

A BELATED recognition of the bid-peddling evil has at last come from the Federal Government in a general order issued on April 9 and addressed "To all Federal Departments and Construction Agencies." The order, which is aimed at general contractors who shop for bids from sub-contractors after the general contract is awarded, reads as follows:

"Every contractor who bids upon a project financed in whole or in part by loans or grants from the PWA shall submit in a sealed envelope with his bid to the contracting authority the names of all sub-contractors and their bids upon which his bid is based. The sealed envelope so submitted shall have on it the name of the contractor with the words thereon 'Bids of Sub-Contractors.' Such submission shall be deemed to constitute an acceptance by the contractor, if awarded the contract, of the bid of each sub-contractor. Any alteration therein, after the ward of the contract, shall be subject to the approval of the contracting officer of the Federal Department or Agency concerned."

The order applies also to contracts wholly or partly financed by PWA money. In fact, the order originated with Secretary Ickes, who issued an earlier letter requiring this action on all bids submitted for PWA projects.


This Laboratory
Operated by the City of Fort Wayne under the direction of the Board of Public Works, is NOT here to cause hardship on any contractor or material producer but is here to see that the Taxpayer Gets Dollar for Dollar when he buys Public Construction Work
1123

At left, sample cores being drilled. At right, exhibit of cores drilled from concrete sidewalks, several of which disclose flagrant cheating

Basic Steps in Control of Concrete

Inter-Relationship Between Mass, Unit Weights, Specific Gravity, Density, Apparent Specific Gravity, Voids, and Concrete Density

By JOHN C. SPRAGUE
Inspector, U. S. Engineers, Huntington District, Hogsett, W. Va.

Technological control of concrete in the field requires, as one of the basic steps, the determination of certain physical characteristics of the ingredients entering the concrete mixture.

This article presents a co-ordination of certain physical properties of the constituents of concrete which must be determined accurately if the best results are to be obtained. This is particularly essential when working on an absolute volume basis.

In the following discussion, material is taken from various sources and put under one heading for the convenience of those who are responsible for the design and control of concrete in the field, making it unnecessary to hunt through several volumes in order to find that which is presented here in compact form.—The Author.

MASS and weight, for all practical purposes in dealing with concrete, may be used interchangeably. They are, in general, numerically equal, although weight is, in reality, a force rather than a quantity of matter.

The term "density" is used to denote the *mass,* or *quantity of matter per unit volume.* In the words of the American Civil Engineers Handbook, "Density is the number of units of mass in a unit volume of a substance."

Thus, for example, in the English system the cubic foot is the unit of volume, and the pound the unit of mass. Since one cubic foot of water is found to weigh 62.4 pounds, we say that in *the English System the density of water is 62.4 pounds per cubic foot.* In other words, it may be said that *density* and *unit weight* (or unit mass) are numerically equal and synonymous in meaning. Relative density is the ratio of a given density to some density taken as a standard.

When pure water at its maximum density (62.424 lb./cu. ft. at 4 deg. C.) is taken as a standard, the relative density becomes the specific gravity. The terms *density* and *specific gravity* are synonymous in engineering work, but will not be so used here in discussing certain physical characteristics of the constitutents of concrete, since there is another form of *density* used in connection with concrete and concreting materials.

Meaning of Density of Concrete

The terms true specific gravity[1] and apparent specific gravity (or density) are used in describing certain porous bodies to distinguish between the density of the substance and the average density of the substance plus the pores (or voids).

The true meaning of density as applied to physics is not taken into consideration in this discussion. The term *density,* as applied to concrete, is represented by the total *volume* of the solid particles in the whole.[2] In the case of aggregate (sand, gravel, stone, etc.), density is the complement of the voids. For example, a material which has 31 per cent voids will have a density of 69 per cent. In the case of concrete, density is represented by the total volume of the solid particles—exclusive of the uncombined water and air voids—entering into a unit volume.

In short, concrete density is the percentage of solids in a porous body expressed by absolute volume. This density may increase as the mass, or unit weight, of the concrete decreases, due to the fact (assuming that all times the minimum of mixing water is used) that in rich mixtures the water-cement ratio is generally lower, and the total water content higher, than for lean mixtures. Conversely, in lean mixtures, the water-cement ratio is higher than the total water content in the mixture is less. Therefore we have the following condition: In the range of plastic mixtures the higher the cement factor (the richer the mix), the greater the compressive strength, but the lower the density and the unit weight of the concrete—the unit weight being affected to a greater degree than the concrete density. There are also conditions where the density of the leaner mix may be slightly less than that of the richer mix, and yet the unit weight be greater; this is obviously due to the great difference in the specific gravities of the ingredients. Of course, where the total water content of the two mixtures is the same, the rich mix will give higher values for both density and unit weight; but where the water-cement ratio is the same the reverse is true.

Voids in cement, aggregates and concrete are simply air spaces between the solid particles and, as stated before, the voids are the complement of the density of the material.

Definitions of Terms Summarized

In dealing with concrete, therefore, it is well to keep in mind that mass and weight are numerically equal; that specific gravity is the ratio between the weight of 1 cu. ft. of a substance and the weight of 1 cu. ft. of water at 39 deg. F. (62.424); that apparent specific gravity takes into account the air spaces in porous bodies; that density as used in dealing with concrete (called concrete density here) is the percentage of solids in a given volume; and that the density and percentage of voids, when added together, equal unity. It will also be well to keep in mind that the apparent specific gravity will be less than, or equal to, but never greater than, the true specific gravity.

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[1] See A.S.T.M. Specification, serial designation: E 12-27.

[2] See A.S.T.M. Specification, serial designation: C 39-33.

Another form of specific gravity used in granular material is "Bulk specific gravity" and is simply the unit weight of the material divided by the weight of the standard.

In designing concrete mixtures it is preferable to use the apparent specific gravity, since it is more direct and convenient. In the final analysis, however, the use of the true specific gravity will give the same results as the use of the apparent specific gravity, providing that the pores of the material are considered. An example will serve better to clarify this matter. Suppose we are using 100 lb. (dry weight) of a sand of which the apparent specific gravity is 2.60, true specific gravity 2.66, and absorption (24 hr.) 0.86 per cent. If we divide 100 by the apparent specific gravity times 62.4 we obtain 0.617 cu. ft., which represents the actual volume occupied by the particles with the pores filled (saturated) or sealed.

True and Apparent Specific Gravity

Now, if instead we use the true specific gravity, the result is a volume of 0.603 cu. ft., which represents the absolute volume of a solid rock matter in the 100-lb. batch—that is, the first result (0.617) less the volume of pore space within the aggregate particles. If now, we add to 0.603 cu. ft. the volume of pore space (volume of water absorbed in 24 hr. $= \dfrac{100 \times 0.86}{62.4} = 0.014$ cu. ft.) we have exactly the same result in either case. Thus $0.603 + 0.014 = 0.617$.

The reason for requiring that the aggregate be saturated in making the specific gravity determination is that the weight, immersed in water, would otherwise be affected by the absorption. To eliminate this error, 24-hr. soaking is required. This should not be confused with the customary practice of using the 3-hr. absorption for making allowance in the water-cement ratio. It will be apparent that the latter enters into only the computation of water quantity, while the 24-hr. soaking is to enable accurate determination of the absolute volume of aggregate.

Any change in the external dimensions of an aggregate particle due to soaking would be so microscopic that the difference between the 3-hr. and 24-hr. conditions would not affect our problem.

There would be a difference between the true and apparent specific gravities of a solid block of limestone due to its pore spaces, just as in the case of sand or gravel or any other granular substance.

According to the A. S. T. M. method of determination, the apparent specific gravity of an aggregate (1933 Standards, Part 2, pages 994-995) shall be calculated by dividing the weight of the dry sample (A) by the difference between the weights of the saturated sample in air (B) and in water (C), as follows:

$$\text{Apparent Specific Gravity} = \frac{A}{B - C} \quad . \quad . \quad . \quad (1)$$

Using the same symbols, the true specific gravity is determined as follows:

$$\text{True Specific Gravity} = \frac{A}{A - C} \quad . \quad . \quad . \quad . \quad (2)$$

The "saturated sample," of course, refers to a saturated, surface-dry condition. When the sample is immersed, and the pore spaces within the particles are filled with water, the weight recorded is the actual weight of solid matter minus the buoyant effect, which is exactly equal to the volume of solid matter in the sample (metric units), since water in water weighs nothing. The denominator of equation (2), above, is therefore the absolute volume of solids in the sample. The weight of the saturated sample, however, is equal to the weight of solid matter plus the weight (and therefore, volume) of water contained within the particles. The denominator of equation (1) is, therefore, the sum of the solid volume plus the pore spaces within the particles, or the total particle volume (apparent absolute volume) of the sample. Thus, if the dry weight of aggregate (*in grams*) is divided by the apparent specific gravity, the result is the actual volume occupied by the aggregate in the concrete mixture. If it is desired to use the true specific gravity, as computed in equation (2), it will be necessary to include, in the absolute volume of water, the volume of water allowed for absorption by the aggregate. The result will then be identical, as illustrated in the example above.

The Absolute Volume Basis

In the design of concrete mixtures it is desirable (and necessary if accuracy is to be had) to deal with the materials on an absolute volume (or apparent absolute volume) basis. When working on an absolute volume basis it is essential that the specific gravities (or apparent specific gravities), voids, and unit weights be known. They should be accurately determined by repeated physical tests and their inter-relationship to each other checked. Quite often in the field the determinations will be made with no effort to determine whether or not the values "dovetail." For instance, let us refer back to the example where we computed the apparent absolute volume and found it to be 0.617 for a sand weighing 100 lb. per cu. ft. It is obvious at first glance that the voids of this material will be unity minus this value, or 38.3 per cent. Now, if this sample were "dry rodded" the unit weight would be increased to about 112 lb. per cu. ft., which would increase the apparent absolute volume to about 0.70, thus reducing the voids to 30 per cent. Thus we have an inter-relationship of voids, unit weight and specific gravity as follows:

$$V_a \times 62.4 \times S_a = (62.4 \times S_a) - W$$

or, $V_t \times 62.4 \times S_t = (62.4 \times S_t) - W$

Where: V_a = Percentage of voids in the material.
V_t = Percentage of voids plus pore spaces within the particles.
S_a = Apparent specific gravity.
S_t = Absolute (true) specific gravity.
W = Unit weight of dry material.
W_1 = Unit weight of saturated and surface-dried material.
P = Percentage of pore spaces within the particles.
A = Percentage of absorption by weight.

Thus:

$$V_a = \frac{(62.4 \times S_a) - W}{62.4 \times S_a}. \qquad S_a = \frac{-W}{(V_a \times 62.4) - 62.4}.$$

$$V_t = \frac{(62.4 \times S_t) - W}{62.4 \times S_t}. \qquad S_t = \frac{-W}{(V_t \times 62.4) - 62.4}.$$

$$V_a = V_t - P.$$

$$W = 62.4 \times S_a) - (V_a \times 62.4 \times S_a).$$

$$W = (62.4 \times S_t) - (V_t \times 62.4 \times S_t).$$

$$W_1 = W + WA.$$

$$P = \frac{WA}{62.4}. \qquad \text{Bulk Sp. Gr.} = \frac{W \text{ (or } W_1\text{)}}{62.4}.$$

If the above manner of checking is followed, it will be impossible to have two or more inter-dependent values which do not agree, as for example a material with a solid volume of 0.60 and a percentage of voids of 33 per cent; this error might conceivably be made in the laboratory, but would be picked up immediately by a little mathematical checking and probably save a lot of trouble later on.

Concrete density (D) is determined as follows:

$$D = \frac{A - (w - c)}{A}$$

Where: A = Volume of concrete for a one-bag mix.
w = Water-cement ratio by volume.
c = Volume of water required to hydrate one cu. ft. of cement.

Or, if the combined water is not to be taken into consideration as one of the solids, then concrete density is—

$$D = \frac{A - w}{A}$$

How Concrete Bridges Increase Their Carrying Capacity

Designs Based on Strength of 28-Day Concrete—Actual Hardening Continues Far Beyond This Period

WITHIN a few years after their completion bridges are often required to carry heavier loads than those stipulated in their design. They have been able to do this because of the use of low unit stresses and high impact factors, providing that their margins of strength were not cut down by deterioration.

Concrete bridges are one type of structure that, granting proper design and construction, actually increase in load carrying capacity with age. This type of structure, to begin with, usually is designed on the basis of the strength of the concrete at the age of 28 days. Actually, the strength is likely to increase quite rapidly for several months longer, and more slowly for a much greater period of time in the case of a bridge, where moisture is present for further hydration of the cement and consequeunt hardening of the concrete.[*]

The following shows how this peculiar characteristic of concrete may be expressed in additional load capacity of a reinforced concrete beam or slab.

Let f_c = the extreme fiber stress in the concrete used in the design;
f'_c = the extreme fiber stress in the concrete resulting from heavier loading;
f_s and f'_s = corresponding steel stresses;
M_s, M'_s, M_c and M'_c = resisting moments of steel and concrete respectively for the design loading and the heavier loading;
k, k', j and j' = usual notation excepting that the primes are for the heavier loading.

Then—

$$f'_c = \frac{f'_s f_c k}{f_s k'} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

$$\frac{M'_s}{M_s} = \frac{f'_s j'}{f_s j} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

$$\frac{M'_c}{M_c} = \frac{f'_c j' k'}{f_c j k} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (3)$$

M_s and M_c may be taken as unity in (2) and (3) and evaluation of the right hand side will give the increase in loading. The same results from (2) and (3) constitute a check on the computations.

Example:

Assume that the original design was based on $f_c = 700$ lb. per sq. in. and $f_s = 16{,}000$ lb. per sq. in., with $n = 15$.

For a balanced design $p = 0.0087$; $k = 0.396$ and $j = 0.868$.

In order to take care of additional loading, it is permissible to stress the steel up to 20,000 lb. per sq. in. This would require an increase in strength of concrete to preserve the ratio between extreme fiber stress and ultimate strength. Take $n = 10$ for this higher-strength concrete. Then

$$k' = \sqrt{2\,pn + (pn)^2} - pn = 0.339$$

and $j' = 0.887$.

Substituting in (1)—

$$f'_c = \frac{20{,}000}{16{,}000} \times \frac{700 \times 0.396}{0.339} = 1{,}022 \text{ lb. per sq. in.,}$$

which is the extreme fiber stress in the concrete corresponding to 20,000 lb. per sq. in. in the steel.

From (2)—

$$M'_s = \frac{20{,}000}{16.000} \times \frac{0.887}{0.868} = 1.277$$

and from (3)—

$$M'_c = \frac{1{,}022 \times 0.887 \times 0.339}{700 \times 0.868 \times 0.396} = 1.277 \text{ (This is a check result.)}$$

Thus, an increase of 25 per cent in the steel stress from 16,000 lb. per sq. in. to 20,000 lb. per sq. in., would allow an increase in loading of 27.7 per cent, with an increase in concrete stress from 700 lb. per sq. in to 1,022 lb. per sq. in., or 46 per cent.

Available data on increase in strength of concrete with age, compiled by the Railways Bureau of the Portland Cement Association, show that the average gains are 46 per cent in six months, 58 per cent in one year, 64 per cent in two years, 96 per cent in five years, and 102 per cent in 10 years.

Various ways will be found by the designer to utilize this property (peculiar to concrete) of increase in strength with age. Provision for future increase in loading requires only that the tension reinforcement be designed for it—the concrete will take care of the increase in loading without additional cost in the original design.

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[*] For an explanation of this continued hardening, see article in April (1931) issue of CONCRETE, p. 15-16, headed "How Concrete in Wacker Drive Attained Great Strength."

Concrete Floor Stops Fire in Loft of Dairy Barn

Hundred Cattle Returned to Stalls Immediately After Fire—No Loss of Live Stock

A FIRE of unexplained origin broke out, late in March, in the second floor or hay loft of a concrete dairy barn near Waukesha, Wis. One hundred cattle were in the barn at the time.

The roof, which was partly of combustible construction, was destroyed along with the highly inflammable contents of the loft, including hay and grain.

The second floor of the building, comprising the floor of the loft, was of reinforced concrete construction supported on the concrete walls. This floor stopped the fire, in spite of the intense heat generated by the burning hay.

As soon as the fire was under control the cattle were returned to their stalls. Not one of the animals was either killed or injured. The concrete floor, meanwhile, served as a roof over the cattle until a new roof was constructed. Complete destruction of this building, even though it might have been covered by insurance, would have been ruinous to the business of this dairy.

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Reinforced concrete floor stops fierce fire in loft of Wisconsin dairy barn. Hundred cattle return to stalls uninjured after the fire

Preformed Plastic Products Code

THE code of fair competition for the Preformed Plastic Products Industry was approved on March 23. This code covers the manufacture and selling of these products, and the term "products" is defined as: Preformed expansion joints, bituminous expansion joints, rubber expansion joints, fibrous expansion joints—either saturated or unsaturated—cork expansion joints as used in concrete and masonry construction, asphalt plank one-half inch or more in thickness, asphalt rail filler, asphalt rail cushion, asphalt cable trunking, rubber manhole cushions, asphalt or rubber sewer pipe belts, asphalt raggle blocks, asphalt cant strips, miscellaneous asphalt premoulded and/or preformed specialties used in construction projects.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

Cement Gun Contractors Industry.—Supplement No. 4 to the Code of Fair Competition for the Cement Gun Contractors Industry, a division of the Construction Industry was approved on March 21.

James M. Myles has been appointed labor advisor by the Labor Advisory Board for hearings on the Concrete Burial Vault Manufacturing Industry code.

Coming Conventions

May 8—Portland Cement Assn. Annual Spring Meeting. Hotel Biltmore, Los Angeles, Calif. Wm. M. Kinney, Secy. and Gen. Mgr., 33 W. Grand Avenue, Chicago.

May 14-17—National Fire Protection Association Meeting. Atlantic City. Robert S. Moulton, Technical Secretary, 60 Batterymarch Street, Boston, Mass.

June 25-29—American Society for Testing Materials. Annual. Chalfonte-Haddon Hall, Atlantic City, N. J.

July—The National Terrazzo and Mosaic Association. 1934 Convention. Toronto. J. M. Fuhrman, Secretary and Treasurer, 524 Brook St., Louisville, Ky.

December 6-7—Highway Research Board, National Research Council. Fourteenth Annual Meeting. Roy W. Crum, Director, 2100 Constitution Avenue, Washington, D. C.

PERSONAL

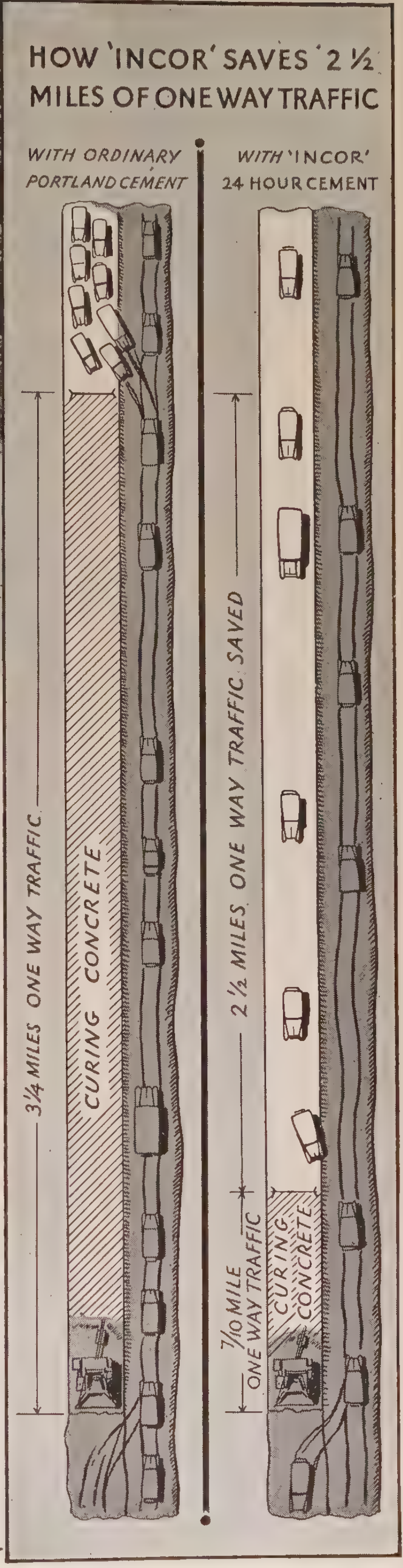
R. C. Yeoman, formerly associated with the Construction Materials Company, is now located with the American Concrete Expansion Joint Company, 221 North La Salle Street, Chicago, Ill.

●

Kay Iverson Church, an agricultural engineer for the Portland Cement Association for seven years and located at Wichita, Kans., was killed in an automobile accident on April 2.

The Midland Bus Came Through on Time

A MIDLAND BUS, bound for St. Louis, rolling over new pavement on U. S. Route No. 12 near Clay City, Illinois. Road repaved in half-width sections, obviating use of bad detour 13 miles longer than main route, over rough, narrow roads. Made possible by good planning and the use of 'Incor' 24-Hour Cement.


HOW 'INCOR' SAVES 2 ½ MILES OF ONE WAY TRAFFIC
WITH ORDINARY PORTLAND CEMENT
WITH 'INCOR' 24 HOUR CEMENT
3¼ MILES ONE WAY TRAFFIC
CURING CONCRETE
2 ½ MILES ONE WAY TRAFFIC SAVED
7/10 MILE ONE WAY TRAFFIC
CURING CONCRETE

24-Hour Cement Eliminates Detours by Half-Width Construction

Detours place a heavy cost-penalty on traffic—due to greater distance traveled, poor condition of road surface, confusion and lost time. The best solution is to keep the main highway continuously open. With 'Incor' 24-Hour Cement this is easily possible. Only where short, paved side-roads are available, or where unusually heavy excavation is necessary, are detours required.

With ordinary Portland cement, one-way traffic through the job is necessary over 3¼ miles of roadway (laying 1800 feet of half-width pavement per day, 10 days' curing); with 'Incor', one-way traffic is reduced to 7/10th mile (laying 1800 feet a day, *24 hours' curing*).

By eliminating 2½ miles of one-way traffic, detouring is no longer necessary; traffic moves freely through the job. 'Incor' also reduces delay 12 minutes per vehicle; decreases travel on sub-grade, effecting one-half cent saving per vehicle-mile. Congestion greatly reduced; traffic uses familiar route. On a 5-mile road project, carrying 2,000 vehicles per day and requiring 48 days for paving, 'Incor' 24-Hour Cement saves $10,000.

'Incor' now costs little more than ordinary Portland Cement—a fraction of resulting economies. 'Incor'* is made by the producers of Lone Star Cement, subsidiaries of International Cement Corporation, New York, and is sold by other leading cement manufacturers.

*Reg. U. S. Pat. Off.

'INCOR' 24-Hour Cement

Part of a crew of 350 CWA workers engaged in widening highways with cement-bound macadam, in the Borough of Richmond, New York City. Hundreds of such projects were built throughout the country by the CWA

Cement-Bound Macadam Found Adapted to CWA Work

May Become Important Activity in Federal Construction Forces Destined to Succeed the CWA

CEMENT-BOUND macadam paving work was found exceptionally well adapted to the limited skill of hastily gathered CWA construction crews, during the past fall and winter. The illustration shows one of hundreds of such projects completed by the CWA, this crew having been part of a group of 350 men employed in widening highways in the Borough of Richmond, New York City.

While the CWA, as such, is now a thing of the past, it is expected that a permanent organization complementary to the CCC will be established as a definite national policy. In that event cement-bound macadam road construction may become one of the most important activities of these construction forces that are destined to succeed the CWA.

Construction Contracts Show Big Increase

March Awards Almost Twice the Figures for February

CONTRACTS for construction work of all kinds, awarded during March in the 37 states east of the Rocky Mountains, were almost twice the total reported for February, and about three times the volume of March, 1933, according to the F. W. Dodge Corporation. The totals follow:

March, 1934	$179,161,500
February, 1934	96,716,300
March, 1933	59,958,500

Contracts awarded during the first three months of 1934 amounted to $462,341,500, compared with only $196,026,800 in the first three months of 1933.

The Brookmire reports emphasize the need for further stimulation of the construction industry as a means of aiding in the recovery of the capital goods industry.

Vast Shortage in Homes

FORTY to fifty million persons are living in inadequate houses and the housing shortage is now more than double that at the close of the world war, W. D. M. Allan, director of promotion of the Portland Cement Association, told a meeting of midwestern cement men recently at Chicago.

Highway Research Board Annual

The fourteenth annual meeting of the Highway Research Board of the National Research Council has been scheduled for December 6 and 7, 1934. As usual the meeting will be held at the building of the National Research Council and National Academy of Sciences in Washington, D. C. Roy W. Crum is director of the board.

From the Patent Office

By J. KAPLAN

Patent Attorney, Washington, D. C.

Forming concrete piles: Werner W. Edman, Lakewood, Ohio. U. S. Pat. 1,935,903, Nov. 21, 1933.—A retaining form is sunk into position and is filled to a desired height with concrete. A mold having the form of the finished pile is then forced into the concrete until the concrete is forced up into the mold. Both the mold and the retaining form are removed when the concrete forming the pile has hardened enough to be self-sustaining.

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Road-building apparatus: Albert F. Reiland, Hackettstown, N. J. U. S. Pat. 1,936,209, Nov. 21, 1933.—The apparatus comprises a wheeled truck adapted to travel on form rails, a grader pivotally carried by the truck, means for raising and lowering the grader, and means for pre-setting the operative depth of the grader, thereby determining the thickness of the concrete pavement.

●

Composite sheeting: Harry E. Holcomb, Bound Brook, N. J., assignor to Fiberfraks, Inc. U. S. Pat. 1,941,985.—The composite sheeting comprises an outer layer of felted asbestos-cement composition containing approximately 20 per cent of mineral fiber and approximately 80 per cent of cement, and an inner layer of a composition consisting of approximately equal parts of organic fiber and cement.

SERVICISED
EXPANSION JOINTS

BRIDGE PLANKING PROTECTION COURSE

SERVICISED Bridge Planking has now been in use for more than seven years! No SERVICISED Planking has ever been replaced where it was recommended for the job. It is made in Standard, Sementread and Rock Surfaced styles and is in use on the main Chicago bridges where probably more traffic is encountered than on any other thoroughfare.

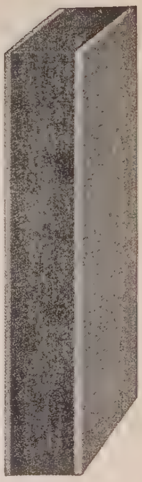
Western Avenue Bridge, Chicago, Illinois

SPONGE RUBBER
CORK
FELT SIDED
PLAIN
COMPOSITION

●

SERVICISED
Expansion Joints

SERVICISED Expansion Joints, whether sponge rubber cork, felt sided, or plain composition, excel! SERVICISED Expansion Joints have given service over a period of twelve years, and are found in State highway work in every State in the Union which has used Expanion Joint within this period. You will not be doing justice to your organization without securing prices and learning about these products.



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ASPHALT PLANKING
STANDARD—SEMENTREAD—ROCK SURFACED

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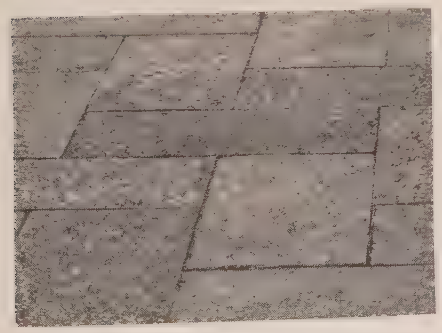

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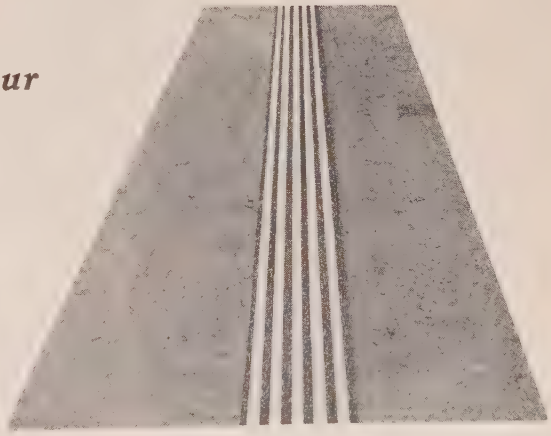
SEMENTREAD planking in six or eight inch widths is highly adapted for road marking purposes having alternate black and white or black and yellow lines—the lines consisting of Portland cement.



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HOW TO DO IT

Questions and Answers
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A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Pitted Surface with Steel Molds

We are having trouble with the formation of small holes in the surfaces of concrete products cast in steel molds, probably caused by air or water bubbles. Vibration has brought about some improvement, but the surfaces are still somewhat pitted. Can you suggest a way to avoid this trouble?—S. O. B., Sao Paulo, Brazil.

This problem is treated in H. L. Childe's book on *Manufacture and Uses of Concrete Products and Cast Stone.* He ascribes the trouble, as you suggest, to the formation of air and water bubbles.

In general, he believes water bubbles are caused by an excess of water in the mixture, while air pockets or pits occur when the mixture is too stiff. He recommends avoiding mixtures that are either too wet or too stiff, and he also urges thorough mixing and tamping. High-frequency vibration should be employed, if possible.

The book just mentioned can be obtained from the Book Department of CONCRETE.

●

Underwriters' Certification of Concrete Building Units

I understand there is in existence a list of hollow concrete building units for which the fire insurance underwriters supply some kind of a certificate of quality. Can you tell me something about this list, and where it may be obtained?—C. E. F., Indianapolis, Indiana.

You are probably referring to the list of manufacturers of hollow concrete building units who utilize the inspection service and certification of quality supplied by the Underwriters' Laboratories. The names and addresses of manufacturers who utilize this service for their products, as an additional assurance of quality, will be found under the heading of "Building Materials" in the List of Inspected Fire Protection Appliances issued by the Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill. Copies may be obtained from the organization just named.

●

Casting Special Facings

What general methods are usually employed in casting special facings on concrete block or cast stone?—M. C. D., Baton Rouge, La.

The face-down method is frequently employed. A layer of the special facing mixture is deposited in the bottom (the finished face) of the mold, this layer having a thickness ranging from ¾ to 1 in. Ordinary concrete is then added, to fill the mold. This second, or ordinary, concrete must be placed before the first layer has set, in order to obtain a thorough bond.

Face plates for the special finish may be made of plate glass if a smooth finish is desired. Or, if ornamental finishes are required, the face plate may be a plaster or concrete casting. A coating of vaseline over the plate will insure easy removal of the finished product after it has hardened sufficiently to be handled.

●

Specifications for Cement-Bound Macadam

We are greatly interested in the article in your January issue on cement-bound macadam and single-track concrete slabs for secondary roads. In my opinion pavements of these types will be able to compete in cost with other types of inferior quality now being placed on secondary roads in our country.—S. F. C., Valparaiso, Chile.

Specifications for cement-bound macadam paving, revised in the light of experience gained from the experimental road built at Elmhurst, Illinois, in 1933, may be obtained from the Portland Cement Association, 33 W. Grand Ave., Chicago, Illinois. A copy is being forwarded to you.

●

Specifications for Terrazzo

Can you refer me to a generally accepted specification for placing terrazzo floor finish—some specification that has been proved up by actual use?—A. S., Troy, N. Y.

A well tried and generally accepted specification for terrazzo work is the standard specification issued by the National Terrazzo and Mosaic Association, 524 Brook St., Louisville, Ky. This specification was adopted after several years of study and discussion by a committee of association members. The members of the committee came from various sections of the country and represented various practices followed in placing terrazzo.

The standard specification developed represents what the committee regards as the best practice for various phases of the work.

●

Concrete Highway Slab Design

I understand a book or pamphlet has been published on the design of concrete slabs for roads and pavements, with particular reference to cross-section, thickness of slab, and reinforcement. Can you refer me to this book?—T. C. S., Ithaca, N. Y.

It is probable that the publication to which you refer is the 60-page booklet on *Concrete Road Design*, by Frank T. Sheets, published in November, 1933, by the Portland Cement Association, 33 W. Grand Ave., Chicago. This booklet was reviewed on page 19 of the December (1933) issue of CONCRETE. A copy may be obtained by addressing the publisher.

BOOKS On Concrete

List No. 1—Reinforced Concrete Engineering Design

(Prices quoted are for cash in advance, and include postage)

GENERAL ENGINEERING HANDBOOK. By Charles Edward O'Rourke and 29 associates. Flexible cover; 921 pages, 5 by 8 in., numerous tables, diagrams, and illustrations. Price **$4.00**

This book assembles a great amount of fundamental engineering data in usable form, 31 separate sections dealing with as many specific branches of engineering. Of particular interest to engineers who specialize in the use of concrete as a structural material are sections devoted to "Highways," by Thomas R. Agg; "Reinforced Concrete Structures," and "Stresses in Framed Structures," by Charles Edward O'Rourke; "Engineering Materials," by Herbert H. Scofield; "Foundations," by Roland P. Davis; and "Mechanics," by Alfred P. Poorman.

REINFORCED CONCRETE CONSTRUCTION. By George A. Hool, Professor of Structural Engineering, University of Wisconsin.

Vol. I—Fundamental Principles. Third Edition. 380 pages, 6x9, 139 illustrations, 18 tables, 28 diagrams **$3.50**

Vol. II—Retaining Walls and Buildings. Second Edition. 700 pages, 6x9, illustrated........ **$6.00**

Vol. III—Bridges and Culverts, 688 pages, 6x9, over 600 illustrations, 41 plates........ **$6.00**

CONCRETE ENGINEERS MANUAL. By Samuel Baker and A. DeGroot. Cloth, 401 pages, 5 by 7½ in., numerous drawings, charts and tables. Price **$3.00**

This volume is intended as a textbook for students of concrete engineering, and as a reference book for designers, foremen, inspectors, and others involved in the design of concrete structures and in the making and placing of concrete. The book contains a complete description of the modern methods of proportioning concrete mixtures, mixing and placing concrete and steel, and providing waterproofing. Mathematical tables and the fundamental principles of mathematics and mechanics of materials, as applied to reinforced concrete designs, are included.

Among other subjects treated in individual chapters are form work, foundations, design of retaining walls, and estimating concrete work.

PRINCIPLES OF REINFORCED CONCRETE CONSTRUCTION. By F. E. Turneaure, Dean of the College of Engineering, University of Wisconsin, and E. R. Maurer, Professor of Mechanics, University of Wisconsin. Fourth Edition. Revised and largely rewritten. 461 pages, 6 by 9. Fully illustrated. Cloth Net **$4.00**

A general textbook on design, including material from actual designs relating to experimental results, and the theory of flat slabs.

CONCRETE ENGINEERS' HANDBOOK. By George A. Hool and Nathan C. Johnson, assisted by S. C. Hollister, and with chapters by Harvey Whipple, Adelbert P. Mills, Walter S. Edge, A. G. Hillberg and Leslie H. Allen. 800 pages, 6 x 9. Illus. Flexible binding. Price **$6.00**

A compact reference book, containing tables, formulae and data on plain reinforced concrete, covering the entire field.

HANDBOOK OF REINFORCED CONCRETE BUILDING DESIGN. By A. R. Lord, Consulting Engineer. 261 pages, 5¼ x 7¼, 156 tables and diagrams. Flexible leather. Price **$1.00**

A compact yet comprehensive handbook for the designer of reinforced concrete buildings. The author has presented numerous tables and diagrams developed as time savers during his extensive experience in the design and construction of buildings. Use of diagrams is illustrated with solutions of typical design problems.

CONCRETE PLAIN AND REINFORCED. By the late Frederick W. Taylor, Sanford E. Thompson, and Edward Smulski. Vol. I. Theory and design of Concrete and Reinforced Structures. 969 pages, 6 x 9, 311 figures, 42 tables, 25 diagrams. Vol. II. Theory and Design of Continuous Beams, Frames, Building Frames and Arches, 688 pages, 6x9, 224 figures, 5 tables, 31 diagrams. Cloth. Vol. I, **$8.00**; Vol. II, **$7.50.**

For more than twenty years "Concrete, Plain and Reinforced" has been the recognized standard in its field. Volumes I and II are far more complete than the earlier editions that appeared in single volumes.

REINFORCED CONCRETE AND MASONRY STRUCTURES. By Hool and Kinne. 722 pages, 6 x 9, illustrated. Price **$6.00**

The work of 14 specialists. This book offers a practical and detailed discussion of every important element entering into the design and construction of concrete and masonry structures. Particularly noteworthy are the very thorough treatments of Reinforced Concrete Buildings, Concrete Forms, Chimneys and Concrete Detailing.

REINFORCED CONCRETE DESIGN SIMPLIFIED. By James R. Griffith, Professor of Structural Engineering, Oregon State Agricultural College. This is the fourth printing of a series of 38 full-page simplified design charts based on the design regulations approved by the Joint Committee on Concrete and Reinforced Concrete, and by the American Concrete Institute. As a designers' aid these charts are indispensable. Price **$1.00**

ELEMENTARY GUIDE TO REINFORCED CONCRETE. By Albert Lakeman. Seventh edition, revised 1930; 94 pages, 79 illustrations. Price **$1.25**

This book is written for the builder, the student, the foreman, or anyone not having a previous knowledge of the principles of reinforced concrete design. Individual chapters cover loads and reactions, reinforcement, neutral axis, reinforced concrete beams, bending moments, shearing stress, reinforced concrete columns and walls, concrete bases, and concrete foundations.

REINFORCED CONCRETE DESIGNERS HANDBOOK. By Chas. E. Reynolds. Published in 1932; 300 pages, 40 designing tables, 51 illustrations. Price **$5.00**

This book contains complete data for the design of all classes of reinforced concrete structures, written by an engineer who is familiar with the designing practice of the leading British specialists in reinforced concrete.

REINFORCED CONCRETE WATER TOWERS, BUNKERS, SILOS AND GANTRIES. By W. S. Gray. Published in 1933; 256 pages, 170 illustrations, 2 folders. Price **$4.00**

Written by an author with practical experience, this book supplies the designer much needed information on the design of structures of these unusual types. The book includes many labor-saving diagrams. Other subjects include heat transmission through concrete walls and calculation of stresses due to hot liquids. A large part of the book is devoted to construction methods and cost estimating.

REINFORCED CONCRETE RESERVOIRS AND TANKS. By W. S. Gray. Published in 1931; 200 pages, 119 illustrations. Price **$4.00**

This book deals in a thoroughly practical manner with the design and construction of plain and reinforced concrete reservoirs and tanks and other water-containing structures both above and below ground level, and both covered and open types. Joints in floors and walls are given special attention.

SPECIAL COMBINATION OFFER: $1.50 (or $2.00 for Cement Mill Edition) added to the price of any of the above listed books will entitle you to one years subscription to Concrete or extend your present subscription one year from its present expiration date. Foreign and Canadian subscribers please write for details.

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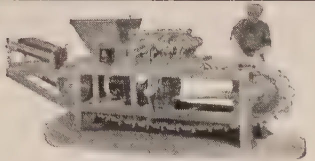

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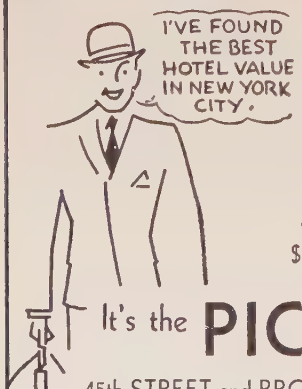
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Concrete Contractors' Meetings Well Attended

Contractors' Attitude Toward Outlook Has Changed from Gloom to Optimism

On page 20 of the February (1934) issue of CONCRETE appears an article telling of the resumption of meetings for concrete contractors sponsored by the Portland Cement Association, and giving a schedule of the meeting dates over a period of several weeks.

The meetings have continued without interruption, the demand for dates having exceeded the ability to fill them. Meetings have been exceptionally well attended, especially since the latter part of February, and enthusiasm is running high. In fact, the mental attitude of contractors seems to have changed completely from gloom to optimism. Meetings scheduled for the next few weeks include the following:

May 1 Tri-City meeting at Le Claire Hotel, Moline, Illinois (to include contractors from Moline, Rock Island, Davenport, and smaller cities).
May 2—Cedar Rapids, Iowa, at the Chamber of Commerce.
May 4—Des Moines, Iowa, at the Kirkwood Hotel.
May 7—Lincoln, Nebraska, at the Lincoln Hotel.
May 8—Omaha, Nebraska, at the Paxton Hotel.
May 8—Madison, Wisconsin, in the council chamber of City Hall.
May 10—Green Bay, Wisconsin, in American Legion Hall.
May 11—Sioux City, Iowa, at the Martin Hotel.
May 15—Minneapolis, Minnesota, in the Builders' Exchange.
May 16—Milwaukee, Wisconsin at the Builders' Exchange Club, 744 North Broadway.
May 18—St. Paul, Minnesota, in the Builders' Exchange.

All these meetings are to be held in the evening, beginning at 8 o'clock. Contractors who have not received notice of meetings in their own territory, and who wish to receive such notice in advance, should write to the Portland Cement Association, 33 W. Grand Ave., Chicago.

Every contractor attending one of these meetings is presented with an extensively illustrated loose-leaf book, or sales manual, entitled "Concrete Jobs: How to Get Them." This book has proved extremely popular at the meetings. Contractors are learning the game of using it.

Salesmanship on the Wing

A NOVEL advertising and selling scheme is used by L. H. Campbell, general manager of the Hazelton Brick Company, of Hazelton, Pa., manufacturers of clay brick, concrete block and concrete tile.

Mr. Campbell, for years, has made a hobby of homing pigeons,. Whenever a prospective customer is discovered in the company's sales territory, which covers a radius of several hundred miles, Mr. Campbell immediately sends a homing pigeon by express. With the pigeon goes a message which is written as though the pigeon were the author. This message extols the advantages and merits of Hazelton products, quotes prices, and winds up sometimes with an invitation to visit the company's plant and enjoy some trout fishing in their private preserve. The pigeon brings back a message or order from the prospect, flying at the rate of around fifty miles an hour. Once a pigeon brought home an order for 600,000 brick.

New Books and Pamphlets

Concrete Arch Design

REINFORCED CONCRETE ARCH DESIGN, by G. P. Manning. Published in 1933 by Sir Isaac Pitman & Sons, Ltd., New York and London. Cloth, 190 pages 5½ by 8½ in. Numerous diagrams and illustrations. Price $3.75.

This book is written primarily for designers of concrete arches, particularly the general run of arches of short and medium span length occurring in daily practice. It provides a definite method, which, if followed step by step, will determine the most economical shape and thickness of arch in any given case.

Values are given for influence lines for a complete range of arches of different shapes and thicknesses, thus eliminating much tedious figuring. Solutions are generally determined by the slope-deflection method.

Austrian Committee Develops New Basis of Mixture Design

MITTEILUNGEN UBER VERSUCHE AUSGEFUHRT VOM OSTERREICHISCHER EISENBETON - AUSSCHUSS, HEFT 14 (Report of Tests Conducted by the Austrian Committee on Reinforced Concrete, Bulletin 14), published by the Osterreichischer Ingenieur- und Architekten-Verein (Society of Austrian Engineers and Architects), Eschenbachgasse 9, Vienna, Austria. Paper cover, 147 pages, 6 by 9 in., with numerous diagrams and illustrations. Price $3.00.

This book sets forth a new basis for the design of concrete mixtures, in which the work of Abrams and Bolomey is continued. The fineness modulus of Abrams has been developed into the kompotenz (particle power), from which the concrete technologist determines the distribution modulus of the aggregates.

Mechanical and nomographic expedients published in the book eliminate the necessity for calculations in the laboratory or on the construction project—an advantage that will be a great aid in the understanding and the practical application of the method.

Annual Meeting of A. S. T. M. Under Preparation

THE thirty-seventh annual meeting of the American Society for Testing Materials, to be held at Chalfonte-Haddon Hall, Atlantic City, N. J., June 25 to 29, is expected to present a full and diversified program of technical papers.

It is significant that many more than the average number of offers of technical papers have been received by the Committee on Papers and Publications. This committee is now at work on the technical part of the convention program.

The thirty-eighth annual meeting of the National Fire Protection Association is to be held May 14 to 17 at Haddon Hall, Boardwalk, Atlantic City. A 24-page program designates the various sessions and the time of meeting.

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BOOKS On Concrete

List No. 2—Concrete Construction, Concrete Making, Cement Manufacture, Concrete Products, Cast Stone and Architectural Concrete

(Prices quoted are for cash in advance, and include postage)

DESIGN AND CONSTRUCTION OF FORM WORK FOR CONCRETE STRUCTURES. By A. E. Wynn. 320 pages, 219 ills., 12 folded inserts and 11 design tables. Cloth bound, stamped title in gold. Price **$6.00**

"Wynn's Book" is a phrase commonly known to engineers, designers, and foremen, and is heard wherever concrete construction is under way. This book covers every phase of forms for concrete construction, and is fully supplemented with many illustrations, tables and drawings and printed on a superior grade of enameled paper.

CONCRETE CONSTRUCTION MADE EASY. By Leslie Turner and Albert Lakeman. 113 pages, 65 illustrations, 16 tables. Cloth bound. Price **$2.00**

A practical book that solves problems in the design and erection of any type of concrete structure. Full designs with tables and all necessary information for building of foundations, walls, columns, floors, roofs, staircases, beams, water tanks, retaining walls, lintels, formwork, saw-tooth roofs, etc. Written clearly and plainly.

CONCRETE WORK. By W. K. Hatt and W. C. Voss. Size 5½ by 8. Illustrated. Cloth bound. Price, Vol. I, **$4.00;** Vol. II, **$2.00.**

A practical book for the contractor and engineer. All phases of concrete building erection are covered.

CONCRETE FORM WORK. By A. B. MacMillan, Chief Engineer, Aberthaw Company; 64 pages, 63 illustrations, stiff paper cover. Price **$1.00**

This book is a reprint of articles printed in CONCRETE throughout 1930. Contains complete details and explanations of concrete form work in all parts of concrete building construction. An appendix describes form work for architectural concrete.

ESTIMATING AND COST KEEPING FOR CONCRETE STRUCTURES. By A. E. Wynn. Published in 1930; 272 pages, 92 illustrations, 2 folders. Price **$5.00**

The author of this book has had a wide experience in contracting for all kinds of concrete structures, and in this volume he publishes his own simple methods of estimating, cost-keeping and book-keeping. Reproductions are given of all blank forms required.

PRACTICAL CONCRETE, comprising Vol. I of a series on "Concrete Engineering." By J. Singleton-Green, Consulting Engineer. Published in 1933; 258 pages; tables, diagrams and illustrations. Price **$3.00**

This book describes in simple language the materials for concrete, designing the mix, and the making, placing and curing of concrete. Individual chapter headings cover normal and special cements, types and analyses of aggregates, admixtures, water and impurities, designing concrete, proportions, mixing, placing and curing. Later volumes will deal with properties of concrete, special cements, etc.

BASIC PRINCIPLES OF CONCRETE MAKING. By Franklin R. McMillan, Director of Research, Portland Cement Association. Ninety-nine pages, 6x9½, 32 illustrations and tables. Price **$2.00**

The author has culled the essentials out of a mass of scientific data on this subject and presents them with force and directness in this book. He shows the effects of quality of material, of proportioning, mixing, working and curing on the finished concrete.

The importance of variable mixes; tests for permeability; how to obtain strength, durability and watertightness; effective ratios; importance of proper construction methods—these and many other vital topics are discussed fully and **authoritatively.**

PLAIN CONCRETE. By Edward E. Bauer, Civil Engineering Instructor, Univ. of Illinois. 346 pages, 6x9, Illus. Price **$4.00**

A complete discussion of cement, aggregates and concrete, covering every detail of production from the selection and preparation of the raw materials to the final sampling and testing. Includes chapters on standard cements, special cements, mineral aggregates, mixing water and admixtures, proportioning, placing, finishing and curing, field control, workability and waterproofness, estimating quantities of materials; also specifications, sampling, testing, etc.

CEMENT CHEMISTRY IN THEORY AND PRACTICE. By Prof. Dr. Hans Kuhl, Director of the Institute for Cement Research, Berlin. Translated into English by J. W. Christelow, B.Sc. 64 pages, 6 by 9, cloth cover. Illustrated with a number of halftones and diagrams. Price **$2.50**

An authoritative book on the chemistry of cement, a translation of a series of lectures delivered by Dr. Kuhl in Moscow, at the special request of the **Soviet government.** The author presents the most up-to-date knowledge of the subject in simple language. The result is a concise record of modern research on the manufacture and setting of cement. Chapter headings are: (1.) The Development of Cement Research; (2.) The Theory of Cement Burning; (3.) The Constitution of Portland Cement Clinker; (4.) The Problem of Hardening and Its Significance in Cement Research; (5) The Chemistry of High-Strength Cements; and (6.) The Technical Aspect of High-Strength Cements.

STANDARD CONSTRUCTION METHODS. By G. Underwood. 408 pages, 330 illustrations. Price **$5.00**

A complete, detailed presentation of actual methods used in practical construction work. A book packed from cover to cover with plans, short-cuts and expedients for construction superintendents and other men upon whom rests the responsibility of getting jobs done quickly and well.

MANUFACTURE AND USES OF CONCRETE PRODUCTS AND CAST STONE. By H. L. Childe. 354 pages. 265 illustrations. Color plates. Photographs. Completely rewritten and enlarged. Price **$3.00**

Deals with problems of how to use dry mixes for architectural concrete; minimize crazing and efflorescence; design all kinds of molds; select materials; grade and proportion aggregates, regulate mixing, and govern curing; use color in concrete; manufacture columns, cornice posts, curb, blocks and slabs, brick, roofing tile, steps, sills, lintels and edgings, balustrades, sundials, bird-baths, lettered panels, ornamental work, etc. This 1930 edition simplifies every phase of manufacture of concrete products and cast stone of every description for every purpose.

PRE-CAST CONCRETE FACTORY OPERATION AND MANAGEMENT. By H. L. Childe. 216 pages, 5½x9, illustrations and layouts. Price **$2.00**

Complete description of the plant layouts, equipment, methods and processes of 20 English manufacturers, large and small. Includes the whole range of pre-cast units from the largest cast stone and roofing tile and plain block plants to the small producers of miscellaneous products.

MAKING PRE-CAST CONCRETE FOR PROFIT: A SYSTEM OF COST-KEEPING AND DETERMINING PROFITS. Published in 1930; 56 pages. Price **$1.75**

A method of keeping costs sufficiently accurate for all practical purposes need not be complicated nor require much time. The system described in this book is simple and easily understood, and can be used by anyone not having a technical knowledge of bookkeeping.

MOLDS FOR CAST STONE AND PRE-CAST CONCRETE. By F. Burren and G. R. Gregory. Heavy board cover, 79 pages, 11 by 7½ in.; 44 full-page illus. Price **$1.25**

Detailed working drawings for the practical mold maker, covering a wide range of concrete and cast stone products. Drawings supply the necessary information, and brief descriptions are given in each case.

A lot of good information for cast stone manufacturers, and for makers of special products ordinary concrete, such as fence posts, chimney caps and pots, well lining, laundry tubs, etc.

CONCRETE MONUMENTS, MAUSOLEUMS AND BURIAL VAULTS. By A. A. Houghton. 65 pages, illustrated. Paper bound. Price **$0.75**

The molding of concrete monuments to imitate the most expensive cut stone is explained in this treatise, with working drawings of easily built molds. Cutting of inscription and designs is also fully treated.

SPECIAL COMBINATION OFFER: $1.50 (or $2.00 for Cement Mill Edition) added to the price of any of the above listed books will entitle you to one years subscription to Concrete or extend your present subscription one year from its present expiration date. Foreign and Canadian subscribers please write for details.

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ORGANIZATIONS

American Association of State Highway Officials; W. C. Markham, Executive Secretary, 1222-24 National Press Building, Washington, D. C.

American Chemical Society, Mills Building, Washington, D. C.

Amercian Concrete Institute; Harvey Whipple, Secretary, 7400 Second Blvd., Detroit, Mich. Thirtieth annual convention, February 20-22, Royal York Hotel, Toronto, Canada.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 West Grand Ave., Chicago.

American Institute of Chemical Engineers, Bellevue Court Bldg., Philadelphia, Pa.

American Railway Engineering Association; E. H. Fritch, Secretary, 59 East Van Buren St., Chicago, Ill.

American Road Builders' Association; Chas. Upham, Engineer-Director, National Press Building, Washington, D. C.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 West Thirty-Ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 260 S. Broad St., Philadelphia, Pa.

Associated General Contractors of America; E. J. Harding, Managing Director, 222 Munsey Bldg., Washington, D. C.

Building Officials Conference of America; Wm. F. Hurd, Secretary, Room 203, City Hall, Indianapolis, Ind.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Cement Institute; H. C. Lundborg, General Manager, 11 East 44th St., New York City.

Concrete Reinforcing Steel Institute; R. W. Johnson, Secretary, 333 North Michigan Ave., Chicago, Ill.

Engineering Institute of Canada; 2050 Mansfield St., Montreal, Quebec.

Highway Research Board; Roy W. Crum, Director, 2101 Constitution Ave., Washington, D. C.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 West Grand Ave., Chicago.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

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National Crushed Stone Association; J. R. Boyd, Secretary, 1735 14th Street, N. W., Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Managing Director, 60 Batterymarch St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

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National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, Earle Building, Washington, D. C.

National Terrazzo and Mosaic Association; J. M. Fuhrman, Secretary-Treasurer, 524 Brook Street, Louisville, Ky.

New Jersey State Concrete Products Association; Horace W. Bush, President, Lyndhurst, N. J.

Portland Cement Association; Edward J. Mehren, President; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary; Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

Wire Reinforcement Institute; R. D. Bradbury, Director, National Press Bldg., Washington, D. C.

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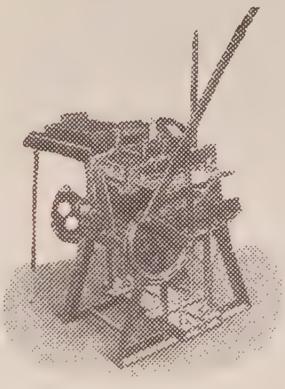

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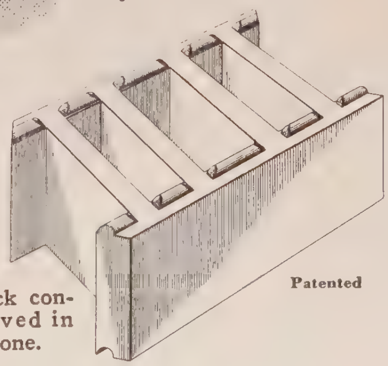

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Equipment and Materials

GMC Model T-16, a 1½-ton truck, offered at a base price of $595, has been announced by the General Motors Truck Company of Pontiac, Michigan. They claim this model incorporates many engineering improvements; a comprehensive line of bodies, combining handsome appearance with quality construction, adapted for practically every variety of demand; comfortable cab for the driver with adjustable driver's seat; 131-inch and 157-inch wheelbase; with 12 colors to select from, all attractive and durable. There are panel bodies, stake and express units, canopy bodies, and platform models.

•

THE Redi-Service truck, a development by which the truck motor is utilized as the solo power unit, has been announced by the Ditwiler Mfg. Co. of Galion, Ohio. The Ditwiler split-shaft power takeoff is the foundation for this development. This device, they claim, can utilize the entire power and torque of the truck motor. A governor control and throttle control are used to secure steady operation at the required speeds.

Redi-Service truck—a standard unit, developed for highway and general utility work, which includes an air compressor with tank, a welder and a self-priming, centrifugal water pump, mounted in a standard or specially designed body, with room remaining for five men

The unit is especially valuable, they say, for emergency work in the field, where quick repairs are imperative on road or bridge, water main, sewer, cable, gas main, etc.

•

INJECTO Prime is the new principle added by the Novo Engine Company of Lansing, Michigan, in advancing the development of self-priming centrifugal pumps. Air is exhausted more rapidly from the suction line, by injecting the air into the recirculating water flowing at a high velocity. The result, they say, is faster prime and higher head.

Manufacturers' News

STEPHENS-ADAMSON Mfg. Co., conveyor manufacturers of Aurora, Illinois, has reopened sales-engineering offices at Pittsburgh and Huntington, West Virginia. The Pittsburgh office is located at 1206 Gulf Building and is under the supervision of Harry W. Banbury, who has long been associated with the firm as purchasing agent and special sales engineer.

The Huntington sales and engineering will be handled by D. W. Allen, a tipple and conveyor expert with years of experience in the West Virginia district.

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THE Pottsco Corporation, Chicago, Illinois, manufacturers of Pottsco lightweight aggregate, announces that effective April 1st, Pottsco is being produced at Bethlehem, Pennsylvania, for the Eastern market. Plans are also under way for Pottsco to be produced at Buffalo, and Sparrows Point, Maryland.

The Pottsco Corporation announces the opening of their New York office at 1440 Broadway, New York City, with A. R. McMullin in charge, handling metropolitan New York and New England. Jack Franklin has been appointed district manager for the state of New Jersey and the Eastern half of Pennsylvania with offices at 60 Park Place, Newark, N. J. A Washington, D. C., office has also been opened in the Metropolitan Bank Building, with L. K. McDorman in charge, covering the territory of Maryland, District of Columbia and Virginia.

The Pottsco Corporation states that hereafter all proposals, quotations and orders will be handled direct by their respective district offices.

Industrial Literature

CONCRETE by Pipe Line is the title of a new booklet describing the Rex Pumpcrete being distributed by Chain Belt Company of Milwaukee. Boulder Dam, U. S. Dam No. 5, U. S. Locks Nos. 4 and 5, U. S. Post Office at Albany, Huey Long Bridge, Barkhamsted Dam, 35th Street Viaduct, Pennsylvania Railroad Union Tunnel, Pennsylvania and New York Central viaducts, San Francisco Oakland Bay Bridge, Herman Biggs Memorial Hospital and the Milwaukee Sewage Disposal Plant installations—all recent American construction activities—are profusely illustrated and described.

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HOW to Paint Concrete and Masonry Surfaces, by the Medusa Portland Cement Company of Cleveland, shows how masonry and concrete surfaces—interior or exterior, damp or dry—can be given a hard, cement-like finish that is permanent, decorative, dampproof, washable and said to be free from the deteriorating chemical action of lime and alkalies and moisture.

•

ELASTITE Subgrade Felt is a light, tough, strong, waterproof paper or felt, which when laid under concrete pavement is said to prevent absorption of water from the fresh concrete into the subgrade, make a complete separation between slab and subgrade, and to eliminate sprinkling of subgrade. A 4-page folder distributed by The Philip Carey Company, Cincinnati, describes, and includes specifications for, this material.

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PLAY at Home on Concrete is another folder with selling ideas for the contractor, published by the Portland Cement Association, Chicago. The illustrations suggest paddle tennis courts, badminton, roque, swimming and wading pools, handball, ping pong, lawn tennis, shuffleboard and checkers. Playground plans for a 50-ft. lot are included.

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ELIMINATE the Guess Work before Starting the Next Paving Job is the subject of a recent folder being distributed by The Dow Chemical Company of Midland, Michigan.

Vol. XLII
No. 5

Cement Mill Section of
Concrete

MAY
1934

Attain Complete Drying of Slurry with New Installation

Develops Excellent Performance Record in German Cement Plant—Mechanical Features of Evaporator—Easily Installed in Existing Plants—Kiln Dust Recovered

By PAUL GOEBELS [1]
G. Polysius, A. G., Dessau, Germany

THE gratifying results obtained with the Lepol kiln in the clinker burning process are well known throughout the world. This process has proved its own case in a large number of installations, and in all these it has given most excellent results. There is no room for doubt that from this process the fact has developed that the rotary kiln, until then quite unsatisfactory from the standpoint of thermal efficiency, has been converted into a burning apparatus of the highest economic efficiency.

The Lepol kiln, in the majority of cases, permits proper utilization of the unevenness of temperature distribution in the rotary kiln. The results obtained in this respect are well demonstrated through the greatly reduced consumption of fuel. The only disadvantage inherent in the Lepol process is that it is applicable only to cement plants operated under the dry process, or plants which readily may be converted to the dry process.

Applicable to Wet-Process Operation

As a consequence of this situation, there emerged the idea of developing a process which would permit attainment of a similar utilization of the gases of rotary kilns operating under the wet process. For some years we have made experiments with the view of absorbing mechanically, by means of filters, the water in the raw slurry; but we were compelled to discontinue those experiments, inasmuch as the methods followed did not permit sufficient utilization of the available quantity of heat. Besides, we were able to prove that not all slurries lend themselves to filtration, so that the method adopted was not applicable to all cases. This point was especially taken into consideration in our experiments, inasmuch as in many cases—for instance, in the planning of an entirely new installation—we could not foresee the physical qualities of the slurries. For this reason, we were obliged to search for another solution to the problem, directing our studies with the view of avoiding the difficulties just mentioned, and obtaining at the same time a recuperation of the kiln gases developed in the wet process, similar to what has been attained for some time with the Lepol system in the dry process.

Process Distinct from Lepol Kiln

Taking into consideration the different physical qualities of the raw material which the slurry represents, with its water content so variable, we had to select an arrangement entirely distinct from the Lepol kiln without losing sight of the basic principle of the Lepol system—the in-

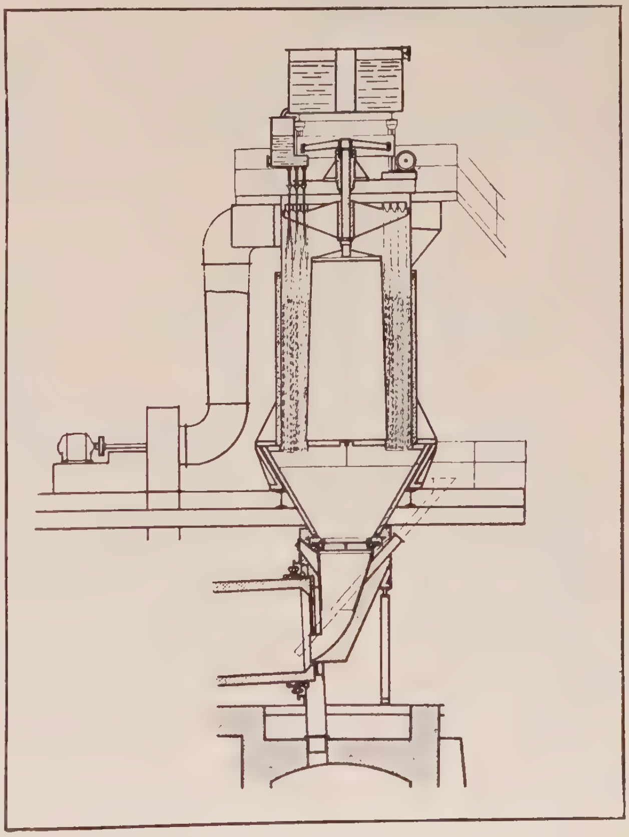

Figure 1. Cross-section of "Evaporator"

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[1] Translated from *Cemento* (Barcelona), issue of October, 1933. Paper presented by the author before the Congress of German Cement manufacturers, May, 1933.

terposition of a heat-absorbing filter or layer in the path of the kiln exit gases. In contrast to what occurs in the Lepol kiln, such an installation could be adjusted to utilize only the temperatures and quantities of available heat necessary to extract the water contained in the slurry, to the end that for the rotating kiln there remains only the further preparation of the material and the calcination of the same.

New Equipment Solves Problem

Today it gives me pleasure to tell you that with the installation which I shall describe to you in detail—that is, the "Evaporator" of the firm of G. Polysius, A. G., Dessau—we have solved this problem in such a manner that in the future it will be possible, in wet-process plants, to combine the advantages which the wet process offers with certain classes of raw materials with the advantages of the high thermal efficiency attained in the new installations.

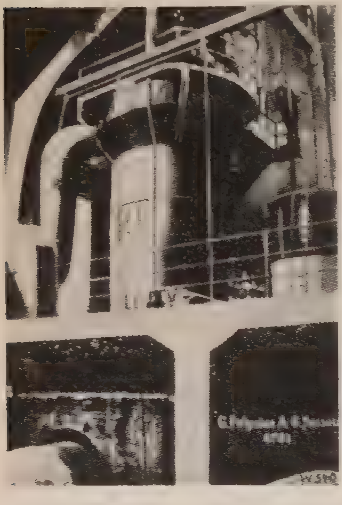

Figure 2. Installation of "Evaporator," at the Maerker cement plant near Harburg, Schwaben, Germany

Main Principle of the Mechanism

The principal idea of this installation consists in bringing into contact with the exit gases of the kiln a metallic surface of the greatest possible area and at the same time distributing uniformly, over this surface, the slurry to be dried. The metal surface serves, then, as a medium for the interchange of heat, while, aside from this, the raw material is able to absorb directly the heat of the kiln exit gases. Two parallel processes, then, take place in this installation. That is, there is a direct absorption of heat by the raw material from the kiln exit gases, followed immediately by an indirect interchange of heat passing from the metallic surface to the raw material. In order to form sufficient metallic surface area for the interchange of heat we have decided upon systems of chains, because these, owing to their form, offer a very large available surface area; and, because of their flexibility, they are unaffected by temperature changes.

Features of New "Evaporator"

Figure 1 shows the basic principles of construction of the "Evaporator," and its method of functioning. Two fixed concentric cylinders form between each other an annular space. The exterior cylinder has an insulated cover, to prevent loss of heat. The inner cylinder is fitted with a cone which conducts the raw material to the feed end of the rotary kiln. This inner cylinder is closed underneath, and serves the sole purpose of compelling the exit gases to pass forcibly through the annular space between the two cylinders. In this annular space the previously mentioned chains for the transfer of heat are suspended in such a manner as to form a dense hanging curtain through which the exit gases are forced. The exit gases then are conducted upward, while the slurry slides slowly in the opposite direction through the chains. The "Evaporator" operates, therefore, in counter-current—that is, the hot gases first come into contact with the slurry at the point where it is the dryest, and leave the "Evaporator" at the point where the slurry is still in a liquid state.

Kiln Dust Recovered in Operation

In this manner there is avoided the loss of a considerable quantity of kiln dust in the exit gases, since the particles of dust carried along with the kiln exit gases are caught in the slurry before the gases pass out of the "Evaporator" at the point where the slurry enters. The outer cylinder is provided, in its upper part, alongside the system of chains, with a spiral channel through which the water vapor arising from the slurry is drawn out through a ventilator and then conducted to the outside air through a chimney.

Shaking Device Keeps Chains Clean

The raw cement slurry has the disadvantage of becoming sticky during the drying process and, at the places where it adheres, at the moment of attaining solidity, it has the tendency to become strongly attached because of the influence of the heat. Therefore it was necessary to arrange a device for shaking the mechanism vigorously at this moment, separating the dried material from the chains. For this reason the suspended chains are not fixed, but by means of a shaking mechanism they are kept in continuous movement, to the end that the surface of the chains be kept continually cleaned and in direct contact with the hot kiln gases. To this end the different systems of chains effect, besides a pendulum movement, a series of move- ’mong themselves. In the construction of this mechanism consideration has been taken of the fact that the strongest movement of the chains is produced at the point where the slurry, in its progress from top to bottom, has lost enough water to cause it to start solidifying.

On many of the chains the slurry begins to adhere as soon as it has acquired a sufficiently stiff consistency, although still brittle. In other parts of the mechanism other chains may be seen, from which the slurry has been shaken, so that the surface of the cleaned chains is again ready to be charged with heat or with another coating of slurry.

Temperature of Gases

As was demonstrated in an installation of this type, the exit gases enter the "Evaporator" with a temperature of 625 deg. C. and leave it through the upper part at a mean temperature of 112 deg. C., both temperatures having been taken at the same instant. The temperature of the gases before entering the "Evaporator" were taken directly at the point of exit from the kiln, while the temperature after passage through the "Evaporator" was measured in the short tube connecting with the aspirator. I wish to emphasize that the operation of the "Evaporator" can easily be so regulated that the temperature at the point of exit will be less than 100 deg. C.

Excellent Performance Under Actual Operation

Figure 2 shows the "Evaporator" installed near a rotary kiln having a diameter of 7 ft. and a length of 138 ft., with a greatly enlarged zone of calcination. Before installation of the "Evaporator" the capacity of the kiln was 92 tons daily, on the average, while after the "Evaporators" was put in operation the average daily output was 115 tons of clinker. The consumption of fuel in the kiln, without the "Evaporator," was 29 per cent of the weight of the clinker produced. After the "Evaporator" was put in operation this consumption of fuel was reduced to 22 per cent of the weight of clinker produced. Besides this increase of 25 per cent in the output of the kiln, there is this important and impressive result, namely, this aforementioned saving of 25 per cent in kiln fuel. The water content of the slurry in this particular case was around 42 to 43 per cent, a relatively high percentage, but necessary because of special conditions pertaining to the raw material.

Practically All Dust Recovered

In this same installation, measurements have been made of the quantities of dust, by means of a Lurgi apparatus, to ascertain the dust content of the kiln exit gases. These measurements were made in the tube connection between the "Evaporator" and the aspirator—that is, before the dust had entered the dust chamber or the chimney; in other words, directly after leaving the "Evaporator." The results of these dust measurements indicated an average of ¾ to 1 per cent of the weight of the dry raw material.

Inasmuch as even this quantity of dust, which is in fact very small, was absorbed further on in the steam chamber, the final result was that scarcely any dust was carried out through the chimney.

Low Power Consumption

It is worth recording also that the power consumption of the entire "Evaporator" installation, including the aspirator and exhauster, is about 34 h.p. From this it will be seen that, based on the output previously mentioned, the power consumption is 5.4 kwh per ton of clinker produced.

Easily Installed in Existing Plant

As another matter worthy to be mentioned, permit me to call attention to the fact that the "Evaporator," as may be seen in Figure 2, could be installed in the existing plant without necessitating any alterations in the construction. In the foreground of Figure 2 may be seen the two rotary kilns, one of which is still operating under the direct feed of the wet slurry. On the platform, shown in the middle of the picture, the "Evaporator" may be seen. On the left side of the "Evaporator" is the tube connecting with the aspirator and, in continuation, the exhauster.

Finally, permit me to say that the installation here described is in operation in the plant of Portland Zementfabrik, Stein-und Kalkwerke, Harburg, August Maerker G. m. b. H., near Harburg, Schwaben (Suabia), Germany.

Review of Future, Present and Passing at American Chemical Society Meeting

Annual Meeting at St. Petersburg Draws Large Attendance

THE papers and discussions at the recent meeting* of the American Chemical Society covered the usual wide range—from developments in every branch of chemistry to extensive industrial activities involving thousands of yards of reinforced concrete and sufficient heavy machinery to interest the most practical. In the field of so-called pure science, chemistry and physics are becoming so much alike and both are becoming so highly mathematical that the terminology is much the same in the three branches of science—the basis of all engineering.

In the Great Procession

In some way, the general character of the meeting called to mind the theme of Lorado Taft's Fountain of Time, and suggested a sort of industrial parallel to that superb work of art. At one end of the procession, passing in review before Time, are scientific discoveries so recently born that they have not ventured beyond laboratory walls to find industrial applications, but carrying with them our hopes for future developments in technology. At the other end of the procession are processes which are generally known to be wasteful and out of date, and are subject to replacement at any time. In the middle is a group of processes so firmly established on scientific principles that they give promise of years of usefulness.

Among the Many New Things

Increasing interest in heavy hydrogen—and particularly its principal compound, heavy water—caused hydrogen to be the most popular element at the meeting. An all-day session was devoted to a symposium on the isotopes of hydrogen. Chemical, physical and biological characteristics were discussed.

The most discussed industrial process was described in a paper on "The Commercial Extraction of Bromine from Sea Water." Not many persons could have heard this paper and viewed the motion pictures presented without being keenly interested. There was just a dash of romance in explaining how modern science has wrested from Father Neptune treasures which he has held through the centuries. This process has been headlined by the press—and rightfully so.

An inspection trip to Mulberry, the center of the Florida pebble phosphate industry, supplied the visitors with much interesting information on the mining, grading and flotation of phosphate rock.

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*The 87th annual meeting of the American Chemical Society, St. Petersburg, Florida, March 26-30, 1934.

◆ EDITORIAL ◆

The Study of Blended Cements

THE committee of three cement men mentioned on page 12 of the April issue of "Concrete" as having been appointed by the American Society for Testing Materials to make a study of blended cements will have an opportunity for real service to the cement manufacturing and concrete construction industries.

Their assignment is a difficult one. They will encounter discouragement and opposition from that dwindling, but determined, group of manufacturers who continue to cling to the somewhat hopeless belief that ordinary portland cement can be made to serve all purposes. The committee must also contend with that group of enthusiasts among cement users who want "a cement for every purpose" without stopping to ask who will see to it that all of the different kinds of cement are always used for the purposes intended.

A safe guess is that the Gardner committee will find a middle-of-the-road solution to the problem. It may reach the conclusion that the industry can develop two or three cements which, among them, will contain all the six or seven special properties demanded in the paper by P. H. Bates presented before the annual meeting of the A. S. T. M. last June, and abstracted on pages 3 and 4 of the August issue of "Concrete." Admitting, for the sake of the argument, that the special qualities suggested by Bates are desirable, there is no reason to doubt that one type of cement may possess more than one of those qualities.

The findings of the Gardner committee may have a far-reaching influence on the future trend of the cement industry.

Watch Those Blasting Caps

WE are again at the season of the year when half-grown children go wandering across country, in search of adventure. It is not in the least surprising that quarries where blasting operations are in progress are a center of interest to them.

Quarry superintendents and blasting foremen should again be warned against the careless habit of leaving blasting caps lying around where children may find them. The warning should be made emphatic, for the year 1933 saw an increase in the number of blasting-cap accidents, as compared with 1932. For some years prior to 1933, each year developed fewer accidents than the year before, indicating that last year there was a let-up in vigilance.

Children find many ways to detonate these caps, often with disastrous results. Just a little carelessness on the part of the quarry blasting crew may, therefore, cause some youngster to face the future maimed or blinded.

The cement industry should not contribute to these distressing casualties.

Silicosis Racket Gets Jolt

AN editorial in the April Cement Mill Edition of "Concrete" discussed the judgment against the Missouri Portland Cement Co. in favor of a workman who claimed to have developed silicosis while in the company's employ.

Quite a different story has since developed in Illinois, in a case against the Marquette Cement Manufacturing Co., this action having been brought in behalf of a former workman at the company's plant at Oglesby, Ill.

Two physicians who testified for the plaintiff were disqualified under cross-examination, the attorney for the plaintiff was later held in contempt of court, and the case was dismissed without being given to the jury.

This Illinois result is encouraging, for it shows the value and effectiveness of an energetic defense, at least when the plaintiff's case is fundamentally weak.

The winning of this case, however, should not be allowed to develop over-confidence on the part of cement plant managements.

Dust elimination should be adopted as a definite policy in all plants where the dust is not now being recovered. In the meantime, workmen operating in dusty locations should wear masks. These precautions constitute the best possible defense.

Christmas Night Cement?

IN a recent lecture on "Your Nose Knows," delivered before the American Chemical Society, Professor Bogert, of Columbia University, discussed the little-understood sense of smell and the unappreciated importance of this sense in the lives of man and other animals. Automatically, and almost unconsciously, many persons smell food, cigars, leather goods, and many other items before purchasing them. Coming closer to home in the building material industries, he said that a house having the clean, inviting odor of fresh paint, varnish and wall paper is more likely to be sold promptly than a house of the same appearance, but having a musty, mouldy odor.

The last few years have brought much diversification in cement—including strength, particle size, color, and type of container. Who knows but that some day cement perfumed with rose, or even Christmas Night, may be specified?

The Heat of Hydration of Portland Cement Pastes

Concluding Article Discusses Determination of Rate of Heat Evolution, and Effect of Surface Area on This Rate—Summary of Facts

By WM. LERCH[†] and R. H. BOGUE[‡]

THE April issue contains Sections I to V of this comprehensive study of the heat generated by cement during the hardening of concrete. The present installment concludes the report on the results of the investigation, and the conclusions drawn.

VI. The Rate of Heat Evolution by the Heat of Solution Method

Several cements were examined by the heat of solution method to determine the quantity of heat evolved at various ages after mixing the paste. For this purpose the cements were thoroughly mixed with 40 per cent of water, by weight, and the pastes placed in one-inch glass vials. The vials were immediately stoppered with corks and sealed with paraffin. The vials were then placed in constant temperature cabinets where they remained until required for the heat of solution determinations. Some of the vials were cured at 25 deg. C. (77 deg. F.) and others at 35 deg. C. (95 deg. F.) to compare the rate of evolution of heat at these different temperatures.

The results obtained from seven cements are given in Table II. In addition to data on composition and gypsum additions, this table contains the data on heat evolved as obtained by the heat of solution method at ages of 1, 3, 7, 28, 90 and 180 days at temperatures of 25 deg. and 35 deg. C. (77 deg. and 95 deg. F.). The 2-day values obtained by the direct method also are included. Woods, Steinour and Starke[11] have computed factors which indicate the contribution of the individual compounds to the heat evolution at ages 3, 7, 28, 90, 180 and 365 days. Seventeen laboratory cements of a wide range in composition were used by those investigators, these being ground to about 99.8 per cent passing the No. 200 sieve. By the use of these factors, values were computed of heat liberation at corresponding ages for the cements examined. These computed values also are recorded in Table II.

The amounts of heat liberated from the above cements at the ages tested are shown in Figure 5.

An examination of the results obtained from these cements confirms the earlier finding that tricalcium aluminate and tricalcium silicate are compounds which contribute large quantities of heat of hydration to the cements at all ages, while the dicalcium silicate and tetracalcium alumino ferrite contribute lesser quantities of heat and at a slower rate. Thus cement No. 3 evolves more heat than cement No. 1, and cement No. 8 evolves more heat than cement No. 6 where the major differences in composition are an increase in the tricalcium aluminate content and a decrease in the tetracalcium alumino ferrite. Also cement No. 6 evolves more heat than cement No. 1, and cement No. 8 evolves more heat than cement No. 3, but in these pairs the major differences in composition are an increase in the tricalcium silicate content and a decrease in the dicalcium silicate content.

The number of cements used in this investigation was not sufficient for a statistical analysis to determine the heat factors for the individual compounds at the different ages of test. However, the calculated values obtained by the use of factors given by Woods, Steinour and Starke are generally in good agreement with the experimentally obtained values at 35 deg. C. The application of those factors, however, can not be expected to be quantitative for the reasons given in the discussion of the direct hydration method.

The values obtained by the direct method at 2 days are in fair agreement with the extrapolated values at 35 deg. obtained by the heat of solution method at 1 and 3 days with one exception. This comparison is not rigid, however, because, by the direct method, the temperature during hydration is not constant whereas, in the heat of solution method, the curing temperatures of the small specimens used remain approximately constant. The general concordance of the results, however, gives assurance of the soundness of the two quite independent methods of examination and permits the extrapolation of data between the early and late periods covered by the two methods.

The amounts of heat available on complete hydration of the cements, as previously defined, have been computed from the compositions and are set down in Table II. By the use of these values, the percentage of the available heat that has been liberated from each cement at each test period has been computed. It is seen that about half of the total available heat is liberated between 1 and 3 days, about three-quarters in seven days, and from 83 to 91 per cent in 6 months, when the pastes are cured at 35 deg. C. (95 deg. F.). It may also be noted that both the total quantity and the rate of heat liberation are greatest with those cements high in tricalcium aluminate and tricalcium silicate.

The amounts of heat evolved at 35 deg. C. (95 deg. F.) are consistently higher than those evolved at 25 deg. C. (77 deg. F.) but the magnitude of the differences is not large.

VII. Effect of Surface Area on Rate of Heat Evolution

Several definite particle size fractions obtained from a commercial cement by air elutriation were examined by the heat of solution method to determine the quantity of heat evolved by the different fractions at various intervals. Pastes were prepared from these fractions in the manner previously described and the pastes cured at 35 deg. C. (95 deg. F.).

The results obtained from these fractions, together with results obtained from the whole clinker as ground, are given in Table III and are shown graphically in Figure 6. The table gives the particle size of each fraction, expressed both in microns and in terms of the surface area of each fraction in sq. cm./g; the oxide composition and the computed compound composition of each clinker fraction; the amount of gypsum added; the calculated heat available from the complete hydration of the cements; the experimentally obtained values of the heat evolved at various intervals; and the values obtained at the various intervals calculated to per cent of the total heat available.

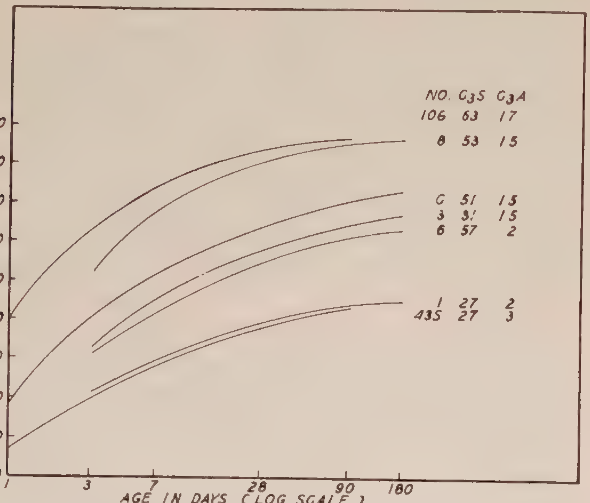

FIG. 5 HEAT EVOLUTION AT 36° FROM CEMENTS OF DIFFERENT COMPOSITION AT AGES TO 180 DAYS

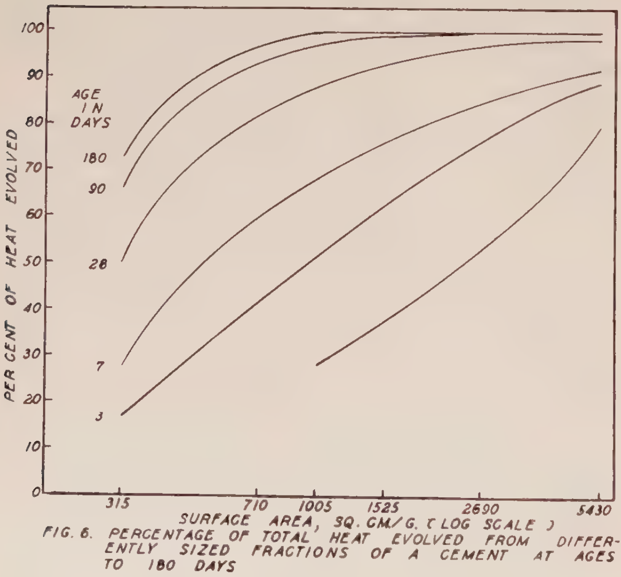

FIG. 6. PERCENTAGE OF TOTAL HEAT EVOLVED FROM DIFFERENTLY SIZED FRACTIONS OF A CEMENT AT AGES TO 180 DAYS

This study did not include all of the fractions separated from this cement, but the number examined covers a wide range of particle size and surface area and was considered sufficient to indicate the effect of particle size on rate of evolution of heat from this cement.

The computed compound composition of the fractions is shown not to be identical, the most pronounced difference being a consistent variation in the calcium silicates present. The tricalcium silicate content decreases and the dicalcium silicate content increases as the particle size increases. This is in agreement with results previously reported by Carlson and Bates.[12] These changes in compound composition bring about a progressive decrease, as the particle size increases, in the computed quantity of heat available upon complete hydration.

The results given in Table III and Figure 6 show a pronounced difference in rate of evolution of heat from the variously sized fractions as indicated by the experimentally obtained values, expressed in *cals/g;* and also as indicated by the computed values showing the per cent of the total available heat that has been evolved at each age. Thus, the 0–5 micron fraction had evolved 87 per cent of its total heat in 3 days whereas the 48–60 micron fraction had evolved only 17 per cent of its heat at that age. At 28 days the fine fraction was almost completely hydrated, whereas at that time the coarse fraction was but 50 per cent hydrated. The intermediate fractions evolved heat at rates which corresponded to their respective surface areas.

A small part of the differences in rate of heat evolution may be accounted for by the differences in composition with respect to the calcium silicates. Tricalcium silicate, which is present in the greatest amount in the finer fractions, hydrates more rapidly than dicalcium silicate. This would tend to accelerate the hydration of the finer fractions. However, the differences in heat liberated due to the slight variations in composition appear to be of minor significance in these separate fractions as compared with the large differences shown to be due to the particle size. This is indicated by the differences obtained for the computed values of the heat available from complete hydration of the several fractions. These variations are relatively small compared to the divergencies in the experimentally obtained values, at early ages, for these various fractions.

It should be pointed out that large differences were observed in the surface areas of the several fractions as computed from microscopic determination of the mean particle sizes. The surface areas varied from 315 sq cm/g in the 48–60 micron fraction to 5,430 sq cm/g in the minus 5 micron fraction. This explains the large differences in rate of heat evolution obtained on these fractions as compared with the small differences observed after 24 hours of the differently ground cements described in Section V. Although surface areas of the cements reported in Section V were not determined, a number of tests have shown that the surface areas that may be anticipated by grinding a clinker (in a laboratory mill) to finenesses of 87.5 and 97 per cent passing the No. 200 sieve range from about 1,800 to 2,500 sq cm/g.

VIII. Summary

1. The partial and total heats of hydration of portland cement pastes have been determined by two independent methods: (1) by measuring the heat of hydration directly, and (2) by measuring the heats of solution in the same solvent of the hydrated and unhydrated samples. The first, or direct method, utilizes a vacuum flask calorimeter and is applicable for ages up to 48 hours. The second, or indirect method, is applicable for ages of 1 day and longer.

2. The total heats available upon the complete hydra-

TABLE II. RATE OF EVOLUTION OF HEAT FROM CEMENTS OF VARIABLE COMPOSITION

No.	1	3	6	8	43S	106	Commercial clinker (C)
Partial oxide composition							
CaO	62.7	64.2	64.9	66.6	62.6	66.6	65.7
Al_2O_3	4.0	6.9	3.9	6.8	4.1	7.4	7.0
Fe_2O_3	5.1	2.0	5.0	2.0	4.7	1.7	2.0
SiO_2	25.5	23.4	22.7	21.0	25.4	19.8	22.1
MgO	2.5	3.1	3.1	3.0	2.8	4.0	2.6
Computed compound composition (%)							
$3CaO.SiO_2$	27	31	57	53	27	63	51
$2CaO.SiO_2$	53	43	22	20	52	10	24
$3CaO.Al_2O_3$	2	15	2	15	3	17	15
$4CaO.Al_2O_3.Fe_2O_3$	15	6	15	6	14	5	6
MgO	2.5	3.1	3.1	3.0	2.8	4.0	2.6
Free CaO	0	.6	.1	2.3	0	1.4	......
Gypsum added	3.8	3.8	3.8	3.8	3.8	3.8	2.5
Computed heat available from complete hydration, *cal/g*	91	112	110	128	93	136	120
Heat of hydration, neat cement, *cal/g*							
1 day Obtained at 25° C.	35	38	44	49			
Obtained at 35° C.					38	71	48
% of total heat obtained at 35° C.					41	52	40
2 days Obtained by direct method	45	64	74	76	42	82	
3 days Obtained at 25° C.	49	61	54	74			
Obtained at 35° C.	51	63	61	82	50	95	67
Computed at 35° C.*	43	66	66	88	44	90	65
% of total heat obtained at 35° C.	56	56	55	64	54	70	56
7 days Obtained at 25° C.	50	71	67	86			
Obtained at 35° C.	57	75	73	97	52	105	90
Computed at 35° C.*	48	73	75	98	49	101	89
% of total heat obtained at 35° C.	63	67	66	76	56	77	75
28 days Obtained at 25° C.	63	82	76	106			
Obtained at 35° C.	70	93	86	113	70	117	95
Computed at 35° C.*	63	87	83	106	66	108	99
% of total heat obtained at 35° C.	77	83	78	88	75	86	79
90 days Obtained at 25° C.	74	94	86	114			
Obtained at 35° C.	76	94	92	117	76	117	101
Computed at 35° C.*	71	92	90	111	71	112	104
% of total heat obtained at 35° C.	84	84	84	91	82	86	84
180 days Obtained at 35° C.	75	98	93	117			106
Computed at 35° C.*	73	96	93	115			108
% of total heat obtained at 35° C.	83	88	85	91			88

*Computed from factors of Woods, Steinour and Starke.[11]

TABLE III. RATE OF EVOLUTION OF HEAT FROM A COMMERCIAL CEMENT AND FROM SEVERAL DEFINITE PARTICLE SIZE FRACTIONS OBTAINED FROM THE CEMENT

Particle size in microns—	Less than 5	5 to 10	10 to 16	16 to 20	20 to 30	48 to 60	Whole cement
Surface area, sq cm/g†	5,430	2,690	1,525	1,005	710	315	1,675
Partial oxide composition							
CaO	66.2	66.2	66.2	66.1	65.9	65.1	65.7
Al_2O_3	7.2	6.8	6.5	6.8	7.0	7.4	7.0
Fe_2O_3	2.0	2.0	1.8	1.9	1.9	2.1	2.0
SiO_2	21.3	21.7	22.3	22.4	22.3	22.3	22.1
MgO	2.6	2.5	2.4	2.4	2.4	2.6	2.6
SO_3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Computed compound composition							
$3CaO.SiO_2$	58	57	55	52	50	45	51
$2CaO.SiO_2$	16	18	21	24	25	29	24
$3CaO.Al_2O_3$	16	15	14	15	15	16	15
$4CaO.Al_2O_3.Fe_2O_3$	6	6	6	6	6	6	6
MgO	2.6	2.5	2.4	2.4	2.4	2.6	2.6
Gypsum added	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Computed heat available from complete hydration, *cal/g*	126	123	120	120	118	117	120
Heat of hydration, neat cement, *cal/g*							
1 day Obtained at 35° C.	99	64	44	37			48
% of total heat liberated	79	52	37	31			40
3 days Obtained at 35° C.	109	88	74	61	47	20	67
% of total heat liberated	87	72	62	51	40	17	56
7 days Obtained at 35° C.	113	100	85	83	69	31	90
% of total heat liberated	90	81	71	69	58	27	75
28 days Obtained at 35° C.	120	104	107	101	101	58	95
% of total heat liberated	95	85	89	84	86	50	79
90 days Obtained at 35° C.	126	120	115	114	109	76	101
% of total heat liberated	100	98	96	95	93	65	84
180 days Obtained at 35° C.	124	120	118	118	112	84	106
% of total heat liberated	99	98	99	99	95	72	88

†Based on calculation from microscopic determinations of diameters.

tion of compounds present in portland cement were found to be as follows:

	cals/g
Tricalcium silicate	120
Beta dicalcium silicate	62
Tricalcium aluminate	207
Tetracalcium alumino ferrite	100

In addition, the following values were taken from the literature:

Magnesia	203
Free CaO	279

The heat of hydration of the calcium sulfate in portland cement, which may have been partially or completely dehydrated during the grinding process, is shown to be inappreciable. The heat of reaction of gypsum and tricalcium aluminate hydrate to form calcium sulfoaluminate is found to be 149 *cals/g* of SO_3.

3. By use of the above heat values, the total heat available on the complete hydration of a clinker or cement may be computed from the composition. Experimental values obtained on a number of clinkers were found to be in good agreement with computed values of heat of complete hydration.

4. By use of the computed values representing heat of complete hydration of a cement, together with heat of solution tests of the original cement and of the paste at any desired age, the percentage of the total available heat that has been liberated at any age of test may be computed. Such computations have shown that a relatively large proportion of the total available heat is liberated in a few days but that the heat may continue to be evolved at a progressively decreasing rate through the later ages.

5. Factors have been computed which indicate the amount of heat contributed by the compounds $3CaO.Al_2O_3$, $3CaO.SiO_2$ and $4CaO.Al_2O_3.Fe_2O_3$ to the total heat liberated during the first 48-hour period after mixing with water. These factors may not be applied rigidly to commercial cements because of indeterminate variables in the latter which affect the rate of heat evolution at early ages, but they may be used under specified conditions of manufacture and test to predict the effect of changes in composition on the rate of heat evolution at early ages.

6. The rate of heat evolution is found to increase as the surface of the cement is increased. With the laboratory-ground cements, herein described, varying in surface area from about 1,800 to 2,500 sq cm/g, differences in fineness resulted in differences in rate of heat evolution during the first few hours after mixing the paste but approached equivalent values in one or two days. A period of many months may be required, however, to bring about a hydration of a coarse fraction equivalent to that brought about in a finer fraction in a few days.

7. The amounts of heat evolved at 35 deg. C. are consistently higher than those evolved at 25 deg. C., but the magnitude of the differences is not large.

References

[11] Woods, Steinour and Starke, Ind. Eng. Chem., vol. 24, p. 1207, 1932; Eng. News Record, Apr. 6, 1933.

[12] Carlson and Bates, Rock Products, vol. 25, no. 21, p. 18, 1932.

Silicosis Racket in Cement Industry Exposed in Illinois Case

Judge Normoyle Dismisses Case Brought Against Marquette Cement Manufacturing Co.—Plaintiff's Doctors Disqualified and Attorney Held in Contempt

THE first of the "silicosis" cases brought against a portland cement manufacturer in the Illinois courts came to trial recently before Judge Normoyle, of the Circuit Court of Cook County.

Joe Sciarini, a laborer in the Oglesby plant of the Marquette Cement Manufacturing Co., brought suit alleging injury to his lungs through silicosis, for which damages of $50,000 were asked. The plaintiff was represented by Attorney Sol Andrews, and the defendant by Edward Zimmerman of Zane, Morse, Zimmerman and Norman, Chicago.

Among the medical witnesses who testified for the plaintiff were Dr. Merril N. Jacobs and Dr. Joseph Fisher. On cross examination the defendant's attorney disqualified the witnesses and impeached certain important testimony. Judge Normoyle later found Attorney Andrews in contempt. The Judge took the case from the jury and dismissed it without hearing the evidence and testimony brought by the defendant.

Since the report of the U. S. Public Health Service (Public Health Bulletin No. 176) covering a three-year study of the dust problem in a typical cement plant, it has been generally conceded by medical authorities that dust incident to that industry does not predispose workers to silicosis or tuberculosis.[1]

The present case calls to mind the manner in which solicitation of industrial cases is carried on in the Chicago district. An inspection of the inside cover page of the current Chicago classified telephone directory reveals an advertisement in bold-face type, followed by a half-tone cut of a pleasant-looking man, said to be the father-in-law of an attorney specializing in the so-called "pneumonoconiosis" cases.

[1] Readers are referred also to an article in the Cement Mill Edition of CONCRETE, October, 1933, pp. 28-29, on "Menace of Silicosis on Increase," and to footnotes in that article in which additional articles and reports are listed.

Illustrating two conveyors of a system of belt conveyors equipped with Link-Belt Anti-Friction Idlers, used by McIntyre Porcupine Mines Ltd., Shumacher, Ont., for handling gold ore. Also shows Link-Belt Tripper for discharging ore to bin.

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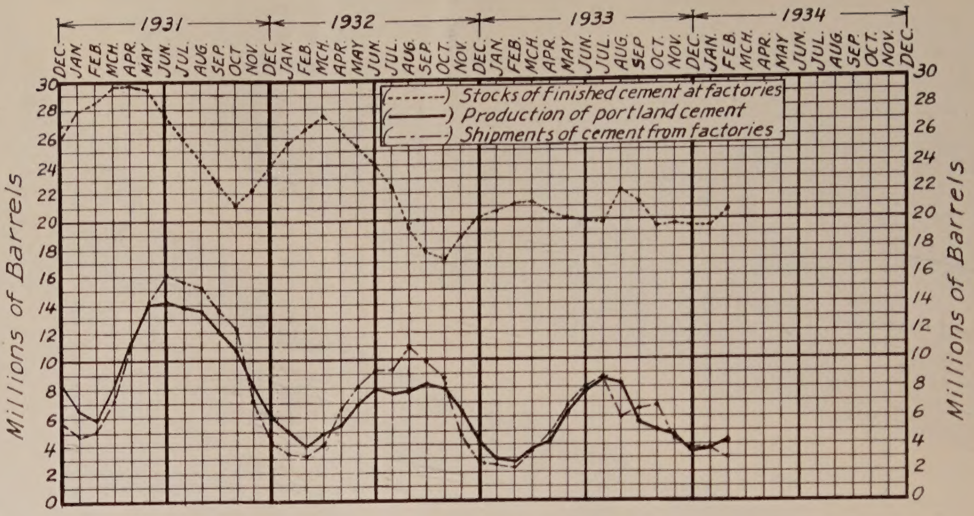
Cement Statistics for February

PRODUCTION of portland cement in February, 1934, showed an increase of 50.1 per cent and shipments an increase of 29.6 per cent, as compared with February, 1933. Portland cement stocks at mills were 1.7 per cent lower than a year ago.



Relation of Production to Capacity (Per Cent)

	The Month	Twelve Months
February, 1934	20.2	24.4
February, 1933	13.4	27.1
January, 1934	16.6	23.9
December, 1933	15.5	23.6
November, 1933	21.2	23.9

Production, Shipments and Stocks of Finished Portland Cement (Barrels)

	1933	1934
Production, February	2,777,000	4,168,000
Shipments, February	2,278,000	2,952,000
Stocks at end of month	21,125,000	20,763,000
Production for year to date	5,735,000	7,947,000
Shipments for year to date	4,780,000	6,730,000

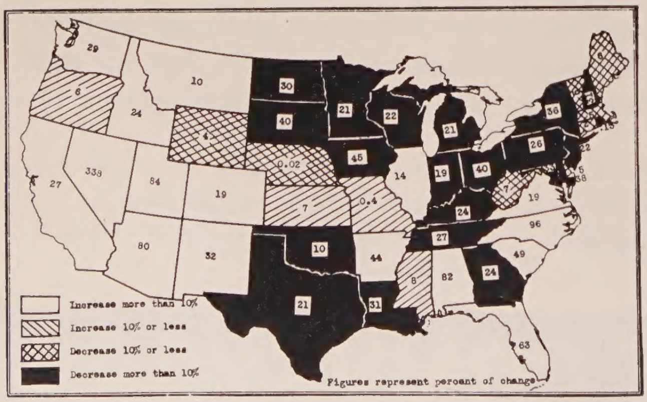
In this statement of relation of production to capacity the total output of finished cement is compared with the estimated capacity of 163 plants at the close of February, 1934, and of 165 plants at the close of February, 1933.

Cement Map Clearing Up

THE cement map of the United States is clearing up. The map here illustrated presents a comparison of shipments of portland cement during two 6-month periods—one ending February 28, 1933 and the other ending February 28, 1934.

The white areas (comprising 16 states) are areas in which cement shipments during the more recent period were more than 10 per cent above the corresponding 6-month period of a year ago. The single-hatched areas (5 states) are states in which the increase was 10 per cent or less.

Double-hatched areas (7 states) show a decrease of 10 per cent or less, as compared with a year ago, while the black areas (20 states) chalked up a decrease of more than 10 per cent.



These black areas, fortunately, are clearing up. The map for the 6-month period ending January 31 had 30 black states. The map covering the full-year period ending December 31, 1933, had 28 black states, and in the previous map (11 months ending November 30) there were 29. The more recent reduction to 20 black states is, in consequence a most welcome indication.

P. C. A. to Meet in Los Angeles

THE annual spring meeting of the Portland Cement Association will be held on May 8 at the Biltmore Hotel, Los Angeles, Calif.

✦ PERSONALS ✦

M. Moss Alexander was elected president of the Missouri Portland Cement Co. of St. Louis, on February 20, to succeed the late Harry L. Block. *George M. Block* was elected first vice-president, succeeding M. Moss Alexander.

Edwin Struckman, general superintendent of the western division of the International Portland Cement Co., residing in Bonner Springs, Kansas, dropped dead on March 15, following a heart attack.

B. J. Latermer of Hinsdale, Illinois, is said to be the new manager in charge of the Three Forks Portland Cement plant at Trident, Montana, succeeding the late Clark Leh, who passed away a few weeks ago.

Oscar Davis, superintendent of the Lehigh Portland Cement Co. plant at Mason City, Iowa, has resigned because of ill health. *H. W. Patterson*, will fill the vacancy.